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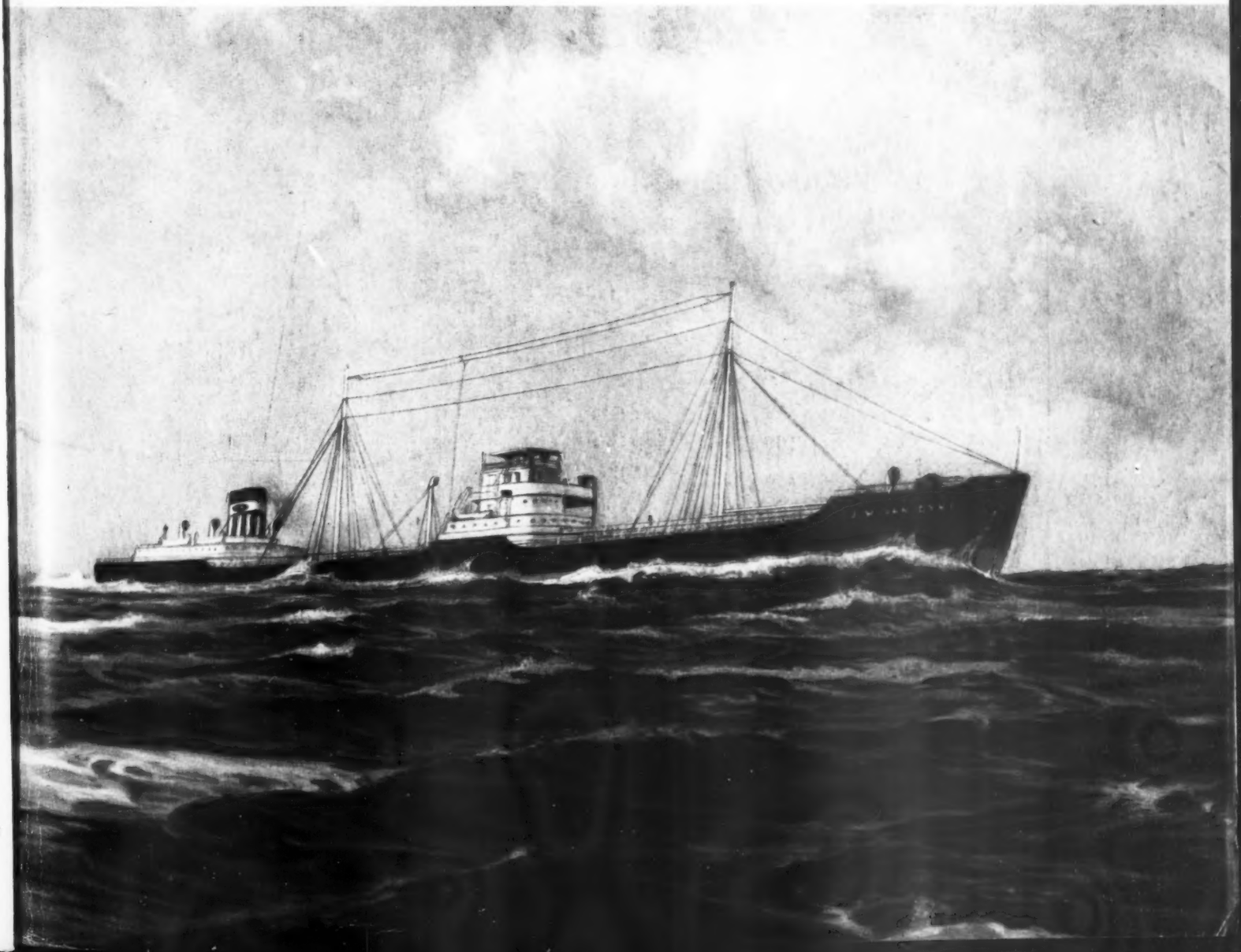

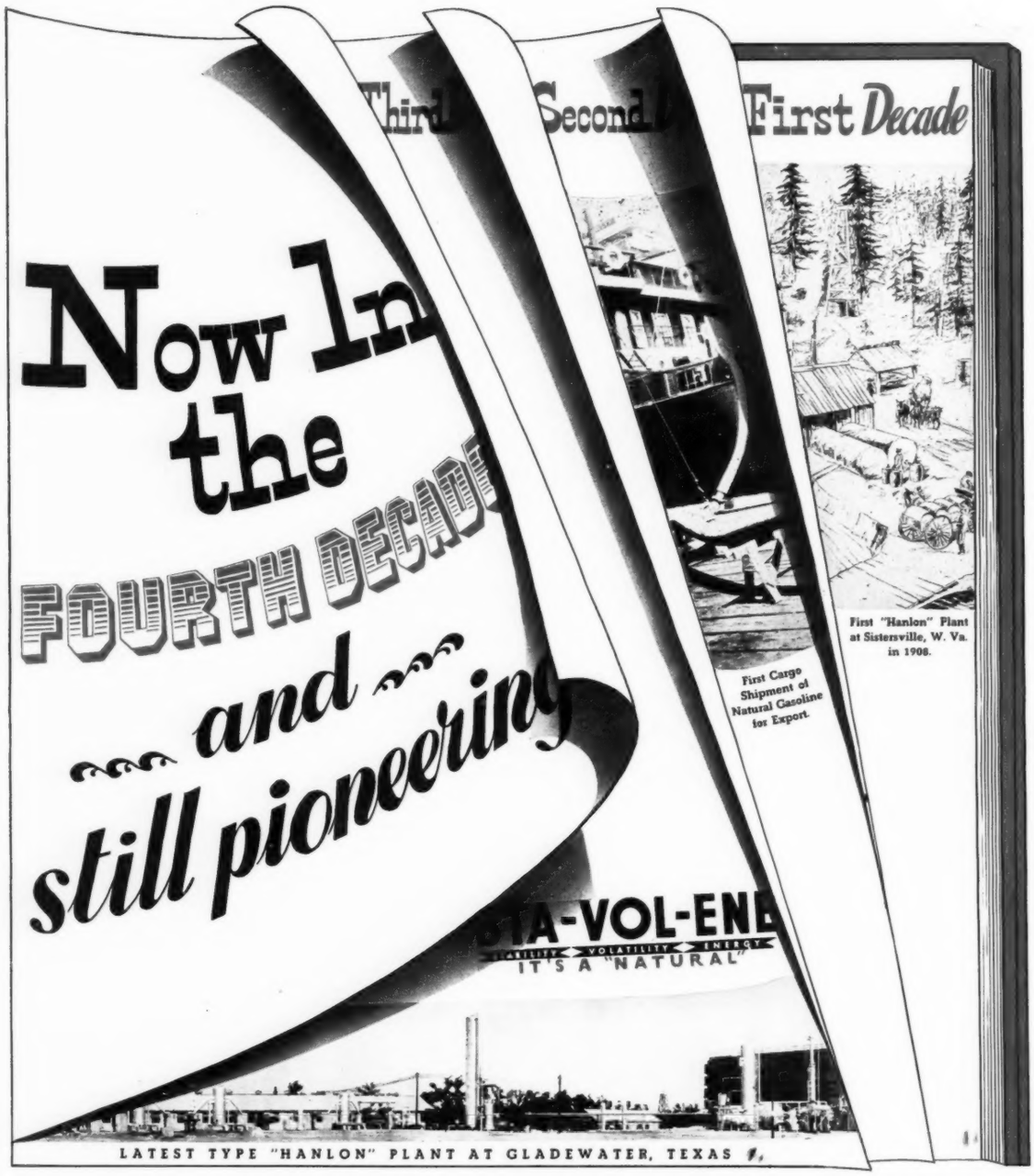
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CONTENTS

Chronology of Events in Mexico . . **39**

Around the World With Frosty Martin . **42**

Humble's Baytown Poly Plant . . **44**

Outlook for Future Tanker Construction **50**

British Shipbuilding **59**

Tankers as Naval Auxiliaries . . . **62**

Foreign Oil Legion **70**

Abstracts of World Oil Literature . . **72**

Gulf Export Prices **84**

Centralamer, Ltd. in Mexico . . . **84**

World Crude Oil Production . . . **88**

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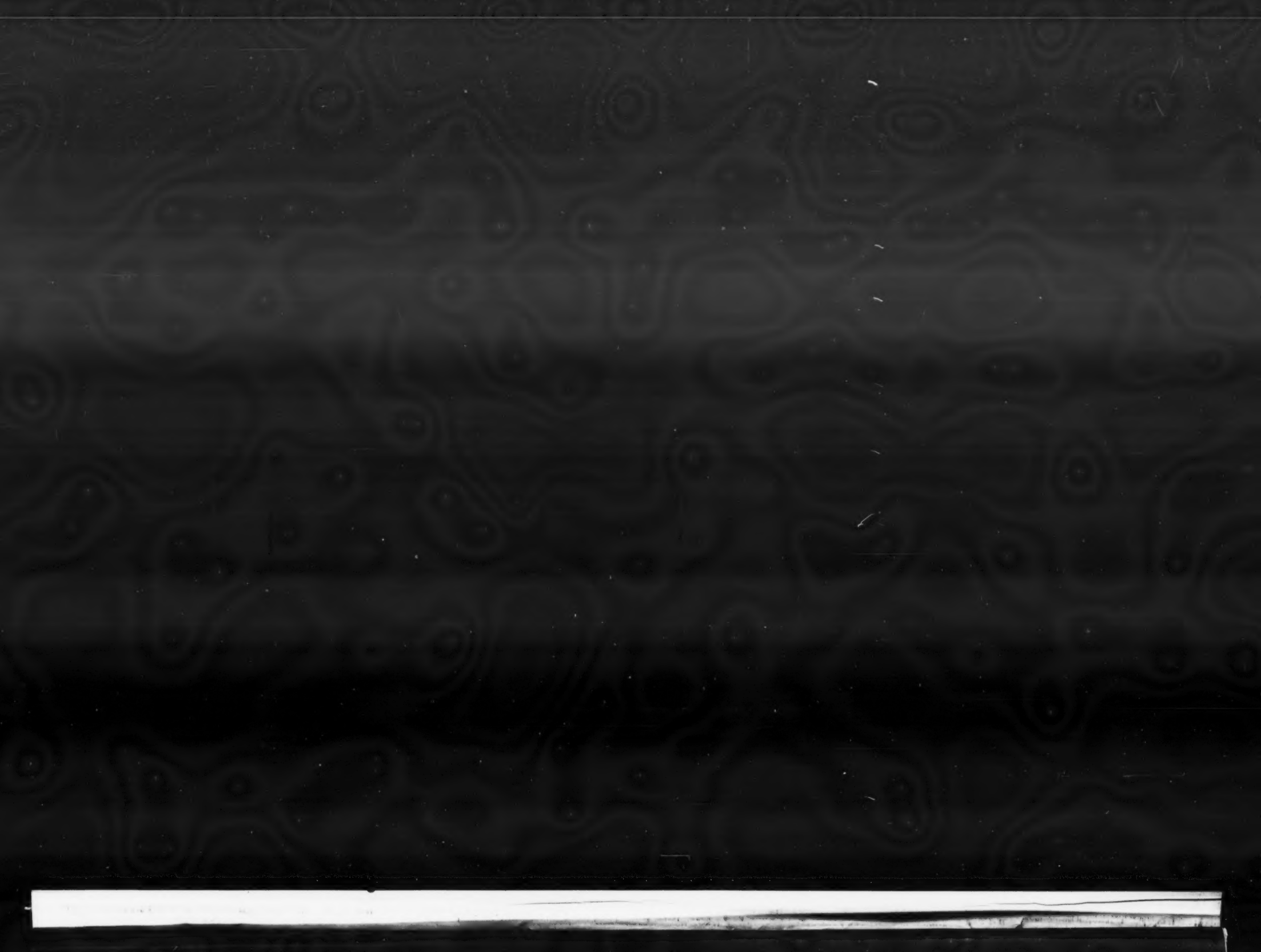


EDITORIAL

OUTSIDE WORLD MUST MEET MEXICO'S CHALLENGE

BY seizing the properties of oil companies operating within its boundaries, evicting the owners and announcing that henceforth the workers of the industry, acting under the direction of the government, will conduct operations, Mexico has issued a challenge to the outside world. At a time when it is becoming increasingly the fashion to violate international comity, disregard promises and trample underfoot the rights of individuals it is important that this challenge should not go unanswered.

It must be understood first of all that the controversy which has been going on between the labor unions supported by the government and the oil companies was not an ordinary labor conflict. While a plague of strikes has afflicted the industry each concession granted by the companies has been the signal for new and more extreme demands, some of them so extravagant that they appear almost unbelievable to an outsider. Even when the companies, in futile hope of preserving some part of their investment, agreed to demands that would have involved a heavy operating loss this offer was refused, ostensibly because they were unwilling to allow union labor representatives who knew nothing of any kind of business to share the management of their properties. The final act of confiscation was not only the logical culmination of the campaign waged against the companies but was obviously its goal.

That the government's concern was not primarily in improving the economic condition of the workers is shown not only by its rejection of the final offer made by the companies but in several other ways. Mexican officials, including a member of the Supreme Court which ruled against the employers in the labor case, have said that the issue was not economic but political. The workers themselves have been told that under government operation they cannot expect to receive the same pay they would have obtained from the companies, that their numbers will be reduced and that those who are still employed must contribute out of their reduced wages to the support of those who are made idle.

A violent campaign of propaganda teeming with misrepresentation has been waged against the oil companies in Mexico for months past. More recently this has been extended to the United States itself. Leaflets distributed by the thousand have been sent out and labor unions with communistic leanings have been urged, and in a few instances have acted, to approve the high-handed course of the Mexican government. The effrontery of the faction now in control of Mexico and the extent to which they have felt they could presume upon the complacency of the government at Washington are indicated by this attempt to sway sentiment in the very country whose citizens are being despoiled.

Despite bold assertions that Mexico cared nothing for the opinion of capitalistic nations, President Cardenas has felt constrained to promise that the British, Dutch, and American companies whose $450,000,000 investment has been seized will be indemnified. Past experience on the part of investors, landowners, and others whose properties have been taken over in similar fashion shows that any such promise, however sincerely meant, is worthless. In a few cases bonds have been issued in payment for confiscated lands but these bonds are practically valueless.

Even before its seizure of oil properties the Mexican government, through its war upon foreign capital which alone was capable of developing the resources of the country and through its expensive program of land socialization, was on the verge of bankruptcy. Today, having driven out the companies which were among the largest contributors

to its federal revenues and having sacrificed the income of $30,000,000 a year which it derived from the sale of silver to the United States Treasury, it faces economic chaos. With the best will in the world—assuming that to exist—it probably would be impossible for Mexico to pay any considerable part of the sum represented by the investments of the oil companies.

The truth is, of course, that Mexico is dependent upon the outside world for a continuation of the rich revenues from the sale of petroleum and its products which in the past has been one of the chief bulwarks of the country's export trade. Seventy-five percent of the oil produced from Mexico's wells has gone to foreign markets and the millions derived from its sale not only have paid wages and taxes but have helped to sustain industry in a multitude of ways. Unless the Mexican government can find accomplices after the fact to aid its larcenous course this trade will be lost.

The nations, companies and individuals who comprise the international market for petroleum have the means not only of registering their disapproval of Mexico's act of brigandage but also of preventing it from being turned to the profit of the aggressor. For those who still hold to ideals of honor, honesty and fair dealing there is no other course than to refuse to traffic in Mexican oil. It is not merely a matter of morals but it is an act of self-preservation to follow such a course. There is abundant evidence that procedure such as that followed by the Mexican government, if it stands unrebuked, inspires imitation and spreads like slow poison, destroying the very life of international trade and sound commercial relations.

Even without international disapproval it is inevitable that Mexico's great petroleum industry will languish. It is no disparagement of Mexican workers to say that they are without the technical and commercial skill to handle the complicated enterprises that are being put in their hands, quite aside from the fact that no previous experiment in such control has succeeded. Even in the Soviet Union which has served as the model for so many of Mexico's recent policies that attempt was long since abandoned.

Other oil producing countries in which higher standards and sounder judgment prevail undoubtedly will receive a large share of the petroleum trade hitherto held by Mexico and will attract to themselves the capital and enterprise that might have been enlisted in proving the great undeveloped resources of the country below the Rio Grande. Mexico, it may safely be predicted, will be a loser by the action she has taken, but that of course will be no consolation for those whose properties have been taken from them.

There is something ironical in the fact that while the teachings and practice that the Cardenas government has followed were inspired by Moscow the power to which it turns with a first offer of its stolen goods is fascist Japan, the most formidable enemy of the Soviet Union. Other negotations with Italy and Germany have been rumored. Within three day after the seizure of the oil properties a Japanese tanker was reported as arriving at a port on the Gulf Coast of Mexico to take on a cargo of oil. At the same time it was announced that negotiations were under way with Japan for the sale to that country of a large quantity of Mexican oil and that an agreement if reached might call for the building of a pipe line to the west coast of Mexico under Japanese supervision. Just a short time before press reports had detailed a plan to deliver over to Japan a mining concession on the Pacific Coast belonging to Bethlehem Steel Corporation.

Influenced by its strong desire to maintain its Good Neighbor policy toward all other countries of the Western Hemisphere, the government of the United States has overlooked many unneighborly acts on the part of Mexico. It has witnessed with only mild protest the seizure of lands belonging to its citizens, the violation of the Morrow-Calles agreement and the erection of discriminating tariffs against its products. It has continued to extend its moral support and financial assistance to the Mexican government. It has been vigilant in preventing the movement into Mexico of arms and munitions that might be used against the government and in suppressing the fomenting on American soil of plots against the constituted authorities of Mexico. Moved by this crowning act of vandalism, however, the Department of State has at length made strong representations to the responsible Mexican authorities and seems prepared to insist that if Mexico takes possession of properties which foreign owners have acquired in accordance with its own laws it must follow the rule of other civilized nations by granting proper remuneration.

In taking this stand, Washington has the cooperation of the British government whose nationals have suffered equal or even greater loss through the oil property seizures. It may be that as a result of the action taken by these two nations which have long shown a friendly interest in Mexico the Cardenas administration will retrace its unwarranted step and come to some agreement by which the oil companies will be left in possession and operation of their properties. Unless some reasonable amend is made Mexico itself is likely to suffer ultimate losses greater than it has been able to inflict upon the objects of its mad attack.

CHRONOLOGY of Factors in Mexican Expropriation —TO APRIL 1, 1938

NOV. 3, 1936 Labor Syndicate notifies oil companies after a convention that a new labor contract applying to the entire industry has been drawn up and must be accepted within 10 days under penalty of a strike. Companies suggest joint meeting. Syndicate declines.

NOV. 27, 1936 Labor Department intervenes. Time for consideration of a modified contract extended to 120 days. Conference of workers and employers called to discuss points in contract but had not finished in 120 days. Syndicate thereupon notifies companies that the strike would begin 28 May, 1937.

MAY 28, 1937 Strike begins. Companies announce they will not be responsible for time or pay lost during strike period.

MAY 30, 1937 Federal Labor Board declares strike legal (companies responsible for wages of strikers during strike period). Companies obtain an injunction against this decision.

President Cardenas advises strikers to desist and submit case to Federal Board of Mediation.

JUNE 7, 1937 Syndicate converts dispute from labor disagreement to economic demand before Labor Board.

JUNE 9, 1937 Strike lifted. Orantes withdraws as chairman of the Federal Board of Mediation. Corono, who had frequently expressed opinions in favor of the Syndicate against the companies, appointed.

JUNE 11, 1937 Companies protest illegality of the proceedings of the Federal Board of Mediation on jurisdictional grounds.

JUNE 15, 1937 Board of Mediation rejects companies' challenge of jurisdiction. Board appoints investigating committee which is to report in 30 days.

AUG. 3, 1937 Findings and recommendations of the Investigating Committee filed.

DEC. 18, 1937 Labor Board renders its award granting full pay for strike period and all demands as regards new working conditions.

DEC. 26, 1937 Companies petition Supreme Court for a writ restraining enforcement of the Labor Board's award.

DEC. 29, 1937 Companies petition Labor Board to suspend this award.

JAN. 1, 1938 Companies file brief stating their position with U.S. State Department.

JAN. 6, 1938 Labor Board renders decision granting no stay in execution of this award excepting in regard to 25 percent of the strike pay. Stay is also granted for execution of the new working conditions involved in their award of Dec. 18 until the Supreme Court had passed on the companies' petition of Dec. 26, 1937. Board also directs that within five days unlimited bond must be given protecting workers from loss resulting from temporary suspension of the award.

JAN. 7, 1938 Companies file a petition with the Supreme Court against this decision of the Labor Board. Bond of 3,000,000 pesos is filed.

FEB. 3, 1938 Newspaper "Excelsior" publishes a statement that Syndicate has the necessary personnel to operate oil industry in case companies withdraw from Mexico. Banquet is tendered to Javier Icaza, judge of the labor section of the Supreme Court by the executive committee of the Syndicate **while the case is pending.**

FEB. 24, 1938 President Cardenas delivers an address stating that the foreign oil companies are inimical to Mexico and they are attempting to bring about an economic crisis to the detriment of the government.

MAR. 1, 1938 Mexican Supreme Court hands down its opinion denying companies petition for a writ (Amparo) restraining enforcement of Labor Board's award after withdrawal of Justice Icaza following companies' challenge of his right to sit, being known as prominent advisor to Syndicate.

MAR. 7, 1938 Companies make a plea before First District Court for suspension of the award because of lack of jurisdiction. Temporary stay is granted.

MAR. 12, 1938 Judge Bartlett terminates the stay on the basis that the interest of the nation demands that the sentence of the Supreme Court be carried out.

Companies meet with President Cardenas and his Ministers in an effort to evolve an effective compromise. Offer to pay 26,329,393 pesos back pay provided objectionable administrative clauses are eliminated. Offer is rejected.

MAR. 18, 1938 President Cardenas issues an Executive Decree expropriating all plant, properties, distribution facilities, tank cars and vessels belonging to the companies. Department of National Economy and Finance receive orders to take possession of the expropriated properties.

MAR. 21, 1938 U.S. Secretary of State Cordell Hull expresses serious concern over the expropriation but hopes for an amicable settlement. These views are conveyed by Under Secretary Sumner Welles to the Mexican Ambassador at Washington Francisco Castillo Majera.

Administrative Council of Oil, appointed to operate the expropriated properties, begins to function.

MAR. 22, 1938 Mexican Eagle Oil Co. charges that the Mexican Government had waited until the company has developed a large new oilfield (Poza Rica) before expropriating their property.

Official support of the peso abandoned, with undetermined depreciation in terms of foreign currency.

Mexican Government reduces oil operations by 50 percent due to lack of storage capacity. Movement of Mexican oil in foreign markets virtually at a standstill since the 18th.

Reports that Japanese interests offer to purchase 12,000,000 bbl. of Mexican crude: deal said to involve Japanese improvements to Mexico's Pacific Coast harbors and construction of pipelines.

MAR. 25, 1938 Mexican Government presents bill for $2,000,000 back taxes to oil companies. Companies deny that they were in arrears in regard to taxes.

Oil companies file supplementary brief with U. S. State Department claiming that there had been a denial of justice.

MAR. 27, 1938 U. S. Secretary of the Treasury announces the decision of the government to defer continuance of the monthly silver purchase arrangement with Mexico.

MAR. 28, 1938 United States Treasury reduces buying price of foreign silver by one cent per ounce to 44 cents thereby bringing down silver prices in London, Bombay, on world markets.

Conference between American oil executives and State Department officials in regard to expropriation held at Washington.

MAR. 29, 1938 United States Treasury reduces price of foreign silver another cent to 43 cents.

U. S. Ambassador to Mexico, Josephus Daniels, presents a strongly worded protest from U. S. State Department to the Mexican Government in regard to expropriation of oil properties. It is emphatically stated that the protest is in no sense an ultimatum.

President Cardenas calls an urgent session of Congress to authorize an internal loan of $20,000,000 to indemnify the companies for seizure of their $400,000,000 oil properties.

President Cardenas also requests of Congress modification of the revised export and import duties that had been raised in January and which had been the subject of a U. S. protest.

Mexican Government starts proceeding to attach companies' bank accounts in Mexico to obtain alleged back taxes.

MAR. 30, 1938 Secretary of State Cordell Hull states that the position of the State Department was that they did not question the right of Mexican government to expropriate property of oil companies but must insist "fair, assured and effective value" be paid to American citizens whose property was seized.

MAR. 31, 1938 Oil companies announce that they are preparing to petition in Mexico for an administrative revocation of the expropriation law.

Oil companies announce also that they are preparing to file injunction suit against the unconstitutionality of the expropriation law.

Francis W. Rickett and Bernard E. Smith reported in Mexico City negotiating contract to purchase large quantities of Mexican Government-produced oil on behalf of unnamed principals.

Oil companies formerly operating in Mexico announce that they will not handle Mexican oil in U.S., Britain or elsewhere.

FRENCH Oil Policy Faces Changed Conditions

By Dr. Kurt Lang

While Many Anticipated Advantages From the Petroleum Policy of 1923 Have Been Realized by the Government, Resulting Technical and Trade Rigidity Has Imposed Great Handicaps on Companies Operating in France.

WHEN, in 1923, France acquired a 23¾ percent share in the future production of the Iraq Petroleum Company, the French government saw the necessity of establishing its petroleum policy on an entirely new basis. Through their participation in the output of the Iraq oil fields the French had acquired, for the first time in their history, what then promised to be a considerable national source of oil, Pechelbronn, the only indigenous field, has never produced more than 75,000 tons a year, amounting to about one percent of French requirements.

After the Iraq deal had been put through the first task of the French government was to arrange for distributing Iraq oil on the French market. In making these arrangements it was necessary to maintain the sales organization of the international oil companies doing business in France because it was clear that the available Iraq production wou'd cover French needs only in part; and further, in case of a new war, the French must again largely depend on these concerns that rendered such valuable service during the world war.

The French government itself was financially interested in the Iraq concession, and it wished the new oil program to be shaped up in a way to improve the French foreign trade balance by restricting future oil imports to crude oil only.

For these reasons the oil legislation adopted has four principal objectives as follows:

1—The formation of the Compagnie Francaise des Petroles, with government participation, which would represent French interests in the Iraq concession and would have charge of the distribution of France's share of Iraq oil.

2—The proration of total imports between this new company and all the other companies heretofore supplying the French market, all of these participants being assigned fixed quotas.

3—The construction of refineries by the holders of import quotas, which would make possible a shift of imports to a crude oil basis and at the same time assure the investment of much capital in France by the international companies. By thus requiring or inducing the international concerns to make these large investments in refinery construction the interests of large international capital groups would be more firmly anchored in the French market, and a greater reserve supply of oil and finished products could be built up in this land poor in oil resources.

4—This legislation would establish the oil companies in a certain degree of dependence on the French government, so that a comprehensive, authoritarian regulation of the oil market could be brought about.

This program brought considerable advantages to the French government. The companies invested between 2,000,000,000 and 3,000,000,000 francs in the thirteen new refineries and gave employment to 8,000 skilled and well paid workers. The construction of these refineries contributed not a little toward delaying the onset of the great depression in France, particularly as it was prescribed that the refineries should be built of French materials. Whereas the capacity of the two refineries existing in 1928 amounted to only 200,000 tons, the 15 refineries now operating have a combined capacity for 6,500,000 tons. This transformation of oil imports to a crude oil basis assured that processing profits would remain in the country, and has resulted in a saving of more than 1,000,000,000 francs in foreign exchange.

The general result has been to make France the principal outlet for Iraq oil. Whereas the French, like their British and American partners, had each a right to only 23¾ percent of Iraq production—that is about 1,000,000 tons each—the French actually received 3,130,000 tons of the total production of 4,200,000 tons, or 74.4 percent, so that Iraq is supplying 50 percent of the total French demand for crude oil. This has naturally reduced exports from the countries formerly selling on the French market, particularly the United States. Whereas the Americans in 1930 supplied 40.8 of the French imports, in 1935 they supplied only 23.58 percent of the crude supply, and in 1937 only 20.27 percent.

For various reasons the contemplated withdrawal of import licenses for finished products has not taken place. Holders of these permits naturally have objected to relinquishing them and have been able to exert sufficient pressure on the government to keep them in effect. Consequently, although the various oil companies have constructed refining capacity sufficient to meet the entire needs of the country they have not been able to employ these facilities fully because of the considerable quantities of petroleum products that continue to come in.

The creation of an entirely new national industry and the improvement of the French petroleum trade balance are not the only benefits that have accrued to the national economy. The grants of import quotas have been tied to certain conditions. Chief of these is the requirement that the oil companies shall maintain on French soil a considerable oil reserve at their own cost; this is a system which has now been initiated in numerous other countries. At the present time oil importers must keep a reserve sufficient to supply the market for a period of four months, so that in case of conflict the country's oil requirements may be covered during at least the initial stages of hostilities, without imposing a burden on the national treasury. Further, through exercise of the licensing power the government has been able to require the oil companies dependent on it to absorb an excess production of alcohol that had accumulated as a result of the agrarian crisis; as in many other countries this alcohol had to be mixed with motor fuel and thus passed on to the public. The same means was employed to assure an outlet for the small amount of synthetic gasoline produced from French coal, although this production has not amounted to more than 40,000 tons a year and is not likely to increase, as the coal deposits of France are not extensive enough to supply other needs for this fuel. Finally, another national advantage was exacted

from the oil importers by requiring 50 percent of oil imports to come in under the French flag.

On the other hand, the obligation laid upon the oil consumers to contribute to the support of the Office National des Combustibles Liquides (French National Office of Liquid Fuels) to support a search for oil in France and the French colonies has not led to any tangible result, although this office has done much to promote the French tanker fleet and in coordinating governmental and private oil interests. In all, some 250 wells have been drilled in France and the colonies, but only in French Morocco have small quantities of oil been found. The two Moroccan wells at Tselfat and Dou Bâal together produce about 6,000 tons a year, and so far the motherland has received only about 2,000 tons from this source. Nevertheless, drilling is still being prosecuted in the overseas possessions; at present explorations in Madagascar appear the most promising.

The above enumerated advantages which the French government has acquired through this transformation of its oil policy are to some extent discounted by certain disadvantages, which are not very well known to the general public. Under the system now in effect it is difficult to harmonize fixed import allotments and a fixed refinery capacity with a change in the character of consumption. The import quotas were purposely set higher than the demand warranted, in order that a bearish influence might be put on prices in favor of the consumers. When the years of upward trends in consumption were succeeded in 1934 by an actual decrease in gasoline consumption, an excess supply beat down the price and the industry suffered much loss. Not until 1936 could the market be brought under control again through the formation of a cartel, the Comptoir Auxiliaire du Petrole, which distributed the unsalable surpluses of its members in such a way that severe shocks to the market were avoided.

Further, the erection of a large number of refineries in a few years according to a preconceived plan had the result of imposing a more or less fixed relation between their outputs of light and heavy oils. It is true that French refinery production is covering three fourths of the domestic demand, but in consequence of the fixity of their original technical method of operation they have, since 1935, been unable to make readjustments that would permit higher outputs of gas oil and fuel oil, the consumption of which has increased greatly. The original policy contemplated (for reasons of trade policy and fiscal considerations) the importation of certain amounts of high grade products, but since 1935 the importation of finished goods has shown a rising tendency; in 1937 the entry of finished goods amounted to 25.2 percent of total oil imports against 19.3 percent in 1935, the first full year of refinery production.

This development is especially emphasized in increased importations of gas oil and fuel oil. Gas oil imports increased from 118,000 tons in 1935 to 215,000 tons in 1937; fuel oil increased from 293,000 to 628,000 tons. This shift in consumption has benefited the United States to the extent of increasing its share of French gas oil imports from 0.6 percent in 1935 to 29.4 percent in 1937 and in the fuel oil imports from 0.8 to 2.7 percent, while keeping its share of imports of gasoline and lubricating oils at the 1935 level. In spite of the tariff margin in favor of the French refineries this tide of imports has not yet reached its high point, and there is in prospect a further shift toward greater imports of gas oil and fuel oil.

This development, which runs counter to the original plan, shows the inconveniences of building refineries in a purely consuming country without indigenous oil supplies, because under such circumstances the refineries are confined to a single market and have no export safety valve.

The difficulty of keeping production would have been less serious if the fiscal measures put into effect by the government had not artificially throttled the demand for motor fuels. The very small growth of gasoline consumption in France has been due in the first place to the continually increased compulsory mixing with alcohol up to 1936, and also to economic and fiscal conditions which imposed an incessant increase in the taxes laid on all power fuels; and particularly to the fact that the franc has decreased in value by 50 percent. Since devaluation has occurred, there has been no decrease in taxation to offset the considerably increased cost (in francs) of imported goods, while the purchasing power of the French consumers has weakened.

French Motor Fuel Price Changes

	CIF Price	Taxes	Wholesale price duty paid Per hectoliter
1928	70.82	70.69	141.51 frs.
January, 1936	27.41	156.61	184.02 frs.
(Before devaluation)			
January, 1938	60.00	157.09	217.09 frs.

Whereas in 1928 the import price and taxes were each a half of the wholesale price for duty-paid gasoline, at the beginning of 1938 and after a devaluation of 50 percent and a substantially lower import price in dollars, the share of taxes in the wholesale price had mounted to 72 percent, leaving only 28 percent to represent the intrinsic value of the goods. This enormous tax load, together with the obligatory mixing with alcohol, has depressed the demand for gasoline, as will appear from the accompanying table.

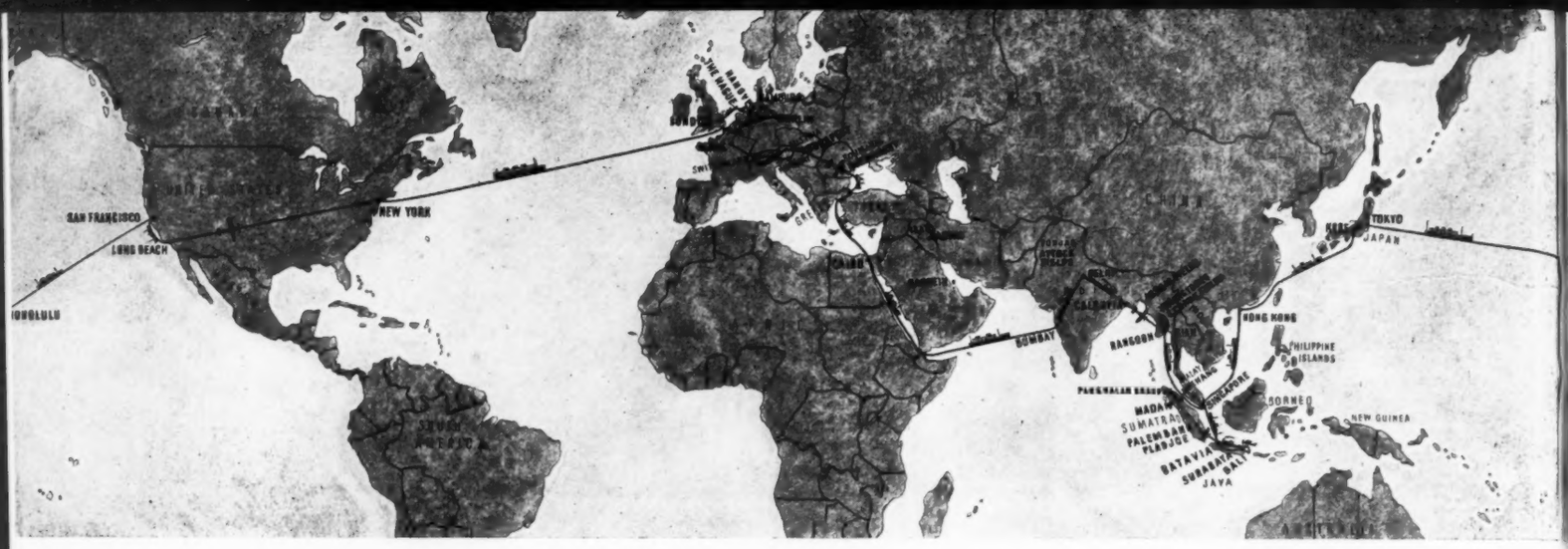
Regional distribution of the fifteen French refineries.

Where in the last few years there has been an increase in the amount of gasoline sold this increase has been due mostly to a decrease in the amount of admixed alcohol. Bad harvests may further decrease the amount of alcohol absorbed by the petroleum industry, and the consumption of gasoline may further increase if no new economic crisis develops. But a real revival of consumption appears questionable, because after a short pick-up in 1936 automobile sales again showed a downward tendency and in 1937 were 2.8 percent under the figures for the preceding year. Also, the increased restrictions put upon truck transportation in order to improve the competitive position of the railroads is a further strong hindrance in the way of an increase in consumption.

The new French petroleum policy has undoubtedly brought considerable advantage from the standpoint of French national economics, but it is now clear that the fixed plan on which the refineries were built has resulted in a certain inelasticity that has to some extent discounted the originally contemplated solution of France's petroleum problem.

French Motor Fuel Consumption
(in thousands of barrels)

Year	Gasoline	Alcohol Mixed	Total	Change
1929	14,120	140	14,260	
1930	16,100	220	16,320	+14%
1931	18,180	350	18,530	+13%
1932	18,930	540	19,470	+ 5%
1933	20,310	1,220	21,530	+10%
1934	19,810	1,450	21,260	— 2%
1935	19,430	2,330	21,760	+ 2%
1936	19,430	2,620	22,050	+ 1%
1937	20,880	1,570	22,450	+ 2%



Around the World With FROSTY MARTIN

By James H. Collins

SUPPOSE you had been born in Pennsylvania, in 1873, when that was the only state in the Union that had oil wells . . . .

Fourteen years after Colonel Drake's first well, which had sixty-nine feet six inches depth, and pumped twelve barrels a day. . .

Suppose that, being born where you were, oil wells had the same fascination for you that airplanes have today, and automobiles yesterday, and railroads to the kids of day before yesterday.

Suppose your Dad was inventive, in the old-fashioned practical way, and by the time you were eight years old had patented the first portable oil drilling machine.

Suppose that the lure of oil just simply got too strong by the time you were fourteen, and you ran away from school, and home, and got an oil well job adapted to your age and strength.

And so on, up until about 1925, after you had stuck to oil all those thirty-eight years, and not only seen the changes in methods, and the increases in depth and production, but had gained an all-around experience of drilling, shop practice and merchandising.

Suppose your Dad's practical inventive streak reappeared in you, and you developed a pressure gauge, and began manufacturing it in Long Beach, California, following up with other instruments to show what was happening down below. The Martin-Decker Corporation, "Frosty" Martin, president. They say the American society of Mechanical Engineers has two members who never went to college. Frosty (W. R.) Martin is one of them. Then, for a dozen years, you improve your instruments, and win over sceptical drillers to their use, and improve them in the light of deeper drilling data that comes steadily from California operations, and by and by found your instruments going out all over the world, into countries with magic names, where new oil fields were being brought in.

And from all around the globe, your customers come to see you. Britishers from the deserts, Hollanders from the jungles, Roumanians, Russians, Germans, Japanese, Latin Americans.

Some of them bring equipment problems, but the majority simply want to meet Frosty Martin, and have him show them the town, particularly Hollywood.

Why "Frosty"?

I asked several people who knew him, and they did not know. So I asked W. R. Martin himself. At sixty-five, his hair is not gray enough to justify such a nickname.

"I've been called that ever since I was a kid," he said, "though I wasn't a towheaded kid, either. It seems to be just one of those things."

And so on, until the year 1937, and one day you suddenly say to yourself, out of the blue:

"Why not pay back some of these calls? Why not go around the world, to see the sights, and also visit as many of the great oil fields as possible? I have friends and customers in all of them—why not see what my friends are doing?"

And so, last July, Martin flew from Long Beach to New York, and boarded the QUEEN MARY with a complete itinerary in his pocket for a west to east encirclement of the globe approximately along the equator, and every great oil field scheduled to the day—almost the hour.

There would be London, and the Hague, with old friends in the Shell and Standard forces. Then the German fields, and the Roumanian fields, and Iraq, Bahrein, Attock, Assam, Chauk, the Malay States, the Dutch East Indies . . .

Boy, what a trip!

But the best laid schemes of mice and men . . . .

In London, his British friends and customers greeted him joyfully, and showed him their town, asking what was the latest news about Ginger Rogers and Claudette Colbert.

"They nearly ruined my stomach," he says.

Frosty stands almost six feet in his stockings, and weighs all of thirteen stone—say 185 pounds. Sociable, gregarious, a born extrovert . . .

If completed in London, that must have been a magnificent ruin!

At intervals in the process of ruining Frosty's stomach, the Londoners said, "Oh, yes, by Jove—you want to see our fields." And time would be taken out seriously to consider the itinerary. Shell and Standard organizations, as well as supply company representatives and the office of WORLD PETROLEUM, arranged for visits to far-flung fields. The illusion that these could all be seen in one trip around the world was successfully maintained, and Frosty took ship for the Hague.

And was shown their town by the Netherlanders, Hollanders, Dutchmen—whatever they prefer to be called.

"And they completely ruined my stomach," adds Frosty.

Also, making serious plans for visiting famous oil fields, without any worry about their friend undergoing much hardship, because they knew in advance that he would probably never reach them.

Frosty was intrigued by names steeped in romance—Mesopotamia, Iraq, Turkestan, Bahrein, the Black Sea, Borneo, Sumatra . . .

But to the Dutch and British oil executives who have won to home office positions by years of field service, these are just

places reached through jungle and desert, often against hostile people.

They mean, not romance, but distance, isolation, heat, insects, baking aridity, steaming humidity—everything in the reality of what writers call "The Lure of Black Gold."

And to the representatives of supply companies they mean even less . . . experienced, they know equipment orders are placed through home offices, London, the Hague—not in desert and jungle oil fields.

From The Hague, the party went into Germany, sight seeing in Berlin, and visiting their first oil fields in Hanover and Hamburg. These are vest pocket fields, with small wells, very spotty, but the fact that oil has been found at all is creditable to German enterprise and science.

Then followed sight-seeing in Belgium, France, Switzerland, Italy, Austria and Hungary. No oil fields, though in Austria there was some drilling going on.

The first country in which an oil man could feel at home was Roumania, fourth in world production. The principal fields were inspected under the guidance of customers and friends.

"The Roumanians have not gone in for depth as we know it," says Frosty, "but they have wells that are not to be sneezed at. Here is the No. 402 well, at Unirea 0.160, in the Tinta field, 7,200 ft. deep, 3,000 bbl. daily, 2,000 lbs. casing pressure, 1,000 lbs. tubing pressure. When I was a kid in Pennsylvania that would have been considered a real oil well!

"Roumania offers the best potential European market for American equipment manufacturers. Production has dropped off considerably, but will probably come up again with some extensions of the older fields.

"Roumanian engineers are alert to the latest American practices and equipment, but when you visit such men, in their own backyard, you get some conception of the difficulties they are up against.

"Not engineering difficulties, but political. You read about blocked currencies, and it doesn't mean anything, but when you talk with good fellows who have to drill and produce oil under such a handicap, you realize that they are on a tough spot.

"Suppose an engineer wants some of our gauges, to get better results. In normal times he would just order them from Long Beach, and in about six weeks have them on the job, but with a blocked currency the procedure is very different.

"First, he makes an application to a government commission which regulates all imports into the country. This commission is made up of good fellows, probably, but they have no conception of what an oil drilling gauge may be. To them, it sounds like nothing important to the prosperity of Roumania, compared with bales of cotton, or automobiles, or a thousand other things for which import applications are pending.

Frosty Martin in a traditional Bali setting: Frosty is the one on the right.

"With good luck, and a lot of explanation, the application for gauges may be approved. Not today, nor next week—say six months.

"Does the engineer get his gauges then? Wait a bit, brother! He takes his approved import application to the National Bank of Roumania, which rations out the limited amount of foreign exchange that can be spent abroad, and the bartering of this for that which goes on in such countries. With a little more luck, the necessary number of Roumanian leis are earmarked for oil gauges, after another six months.

"Then he gets his gauges—and by that time they are obsolete, because we have improved them."

But this Roumanian engineer has one out.

Germany is a good customer for Roumanian gasoline, fuel oil and crude, and will pay for them in goods, and the Germans copy American oil equipment with some humorous results.

Our equipment is designed for wells much deeper than any known abroad, and as depths constantly increase, the equipment is improved.

"Our gauges never wear out," observes Frosty, "and so the only way we can keep on selling them is by making improvements."

If the Roumanian engineer makes a horse trade for German equipment, copied from the American, by the time he gets it the American equipment may have been improved several times, and the copy is out of date.

After Roumania came the Black Sea, and then the itinerary said: "To Cairo, fly to Bagdad, and thence by train to Iraq and the Bahrein Islands."

In Long Beach, that looked like good economic planning. Even in London and The Hague it looked feasible. But in Cairo it was something else again.

Air service to Bagdad had been discontinued. These Persian fields could be reached by backtracking to Athens. But it was hot. Slow travel made the trip cost more than it was worth in time and discomfort, and so it was cancelled.

Provisionally—the party went to Bombay by ship, with some intention of reaching Bahrein through the Persian Gulf. But this, too, proved to be a long, hot trip, with plenty of heat and mosquitos. Petroleum engineers who had been there assured Frosty that Bahrein is neither a summer nor a winter resort—just another oil field.

From Bombay, the itinerary pointed to Delhi, and indicated a trip to the Attock oil field in the Punjab.

"Well, yes, but there's a little trouble up on the border near that field," said a returning geologist, just come from there. "The trains are loaded with soldiers. Anyway, it's just like every other oil field. You wouldn't see a thing you can't see right around Long Beach."

And so, for Attock, another cancelation.

From Delhi, he took train to Calcutta, across steaming India, with the idea of going to Assam to see the operations of the Burma Oil Company at Digboi.

But this was a two-day ride on an Indian railway much less comfortable than the one across from Bombay, and again a petroleum engineer came out of the jungle and said, "Unless it's absolutely necessary, forget it—you won't see a thing."

From Calcutta he went to Rangoon, and flew up the Irrawaddi river to Yenangyoung, and managed to set foot in oil country, the first since Roumania, meeting many old friends and customers in the Chauk and Yenanyoung fields.

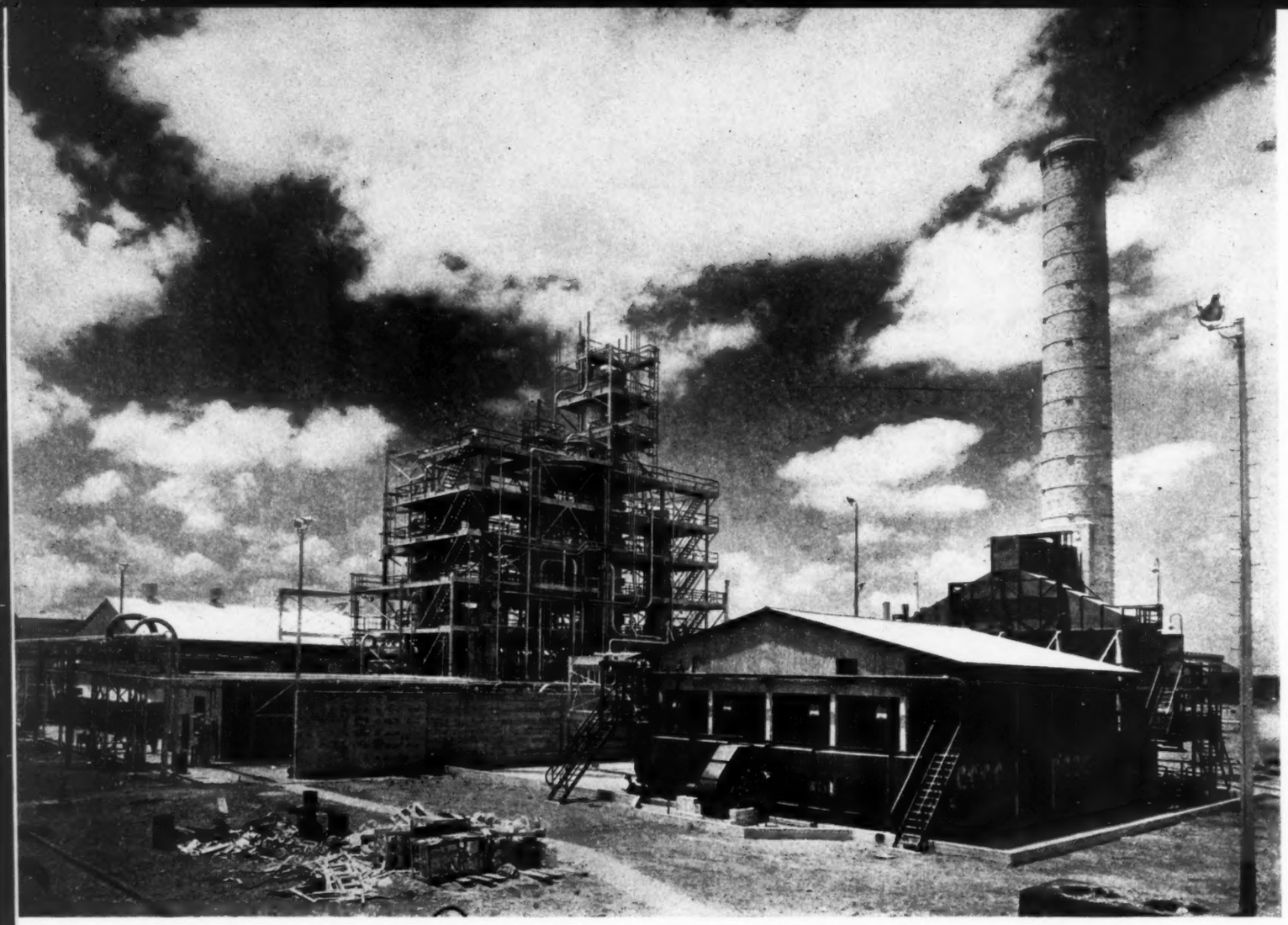
Thence by air to Singapore, back to Penang in the Malay States, and across to Madan, in Sumatra.

Now he was in Dutch Shell and Standard Oil country, and in Netherlands India he saw more oil fields than in any other leg of the tour.

The Shell camp at Pangkalan Brandon was visited, and the fields out of there, then on down to Palembang to see the Shell and Standard operations at the latter place. Both companies have their headquarters at Pladjoe, and Frosty found many more old friends. After visiting the fields out of Pladjoe, he flew to Batavia, and renewed acquaintance with the Standard administrator, another old friend.

At that time, Standard operations in Java were limited to the drilling of one well, but there was a good deal of reconnaissance work going on, especially air photography and seismography.

(Continued on page 86)



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WORLD'S LARGEST Thermal Polymerization Unit Put Into Operation at Humble Refinery

By S. D. Turner and M. W. Mayer

ON June 10, 1937, the Humble Oil and Refining Company put into operation at its Baytown Refinery a thermal polymerization unit to convert butanes and propane into high octane polymer gasoline, thereby completing the last unit in its extensive program for the conservation and utilization of excess butanes and propane recovered in the East Texas oil fields and produced in the refinery. The unit was designed to produce 3,260 bbl. per day of polymer gasoline from 6,700 bbl. per day of fresh feed containing 15 percent (by weight) butylenes, 20 percent isobutane, and 65 percent normal butane. However, it has been operated at fresh feed rates of 10,000 bbl. per day to produce nearly 3,500 bbl. per day of gasoline by discarding some of the propane cycle stocks, and changes are contemplated which may increase gasoline production to about 4,500 bbl. per day from a fresh feed of approximately 12,000 bbl. per day.

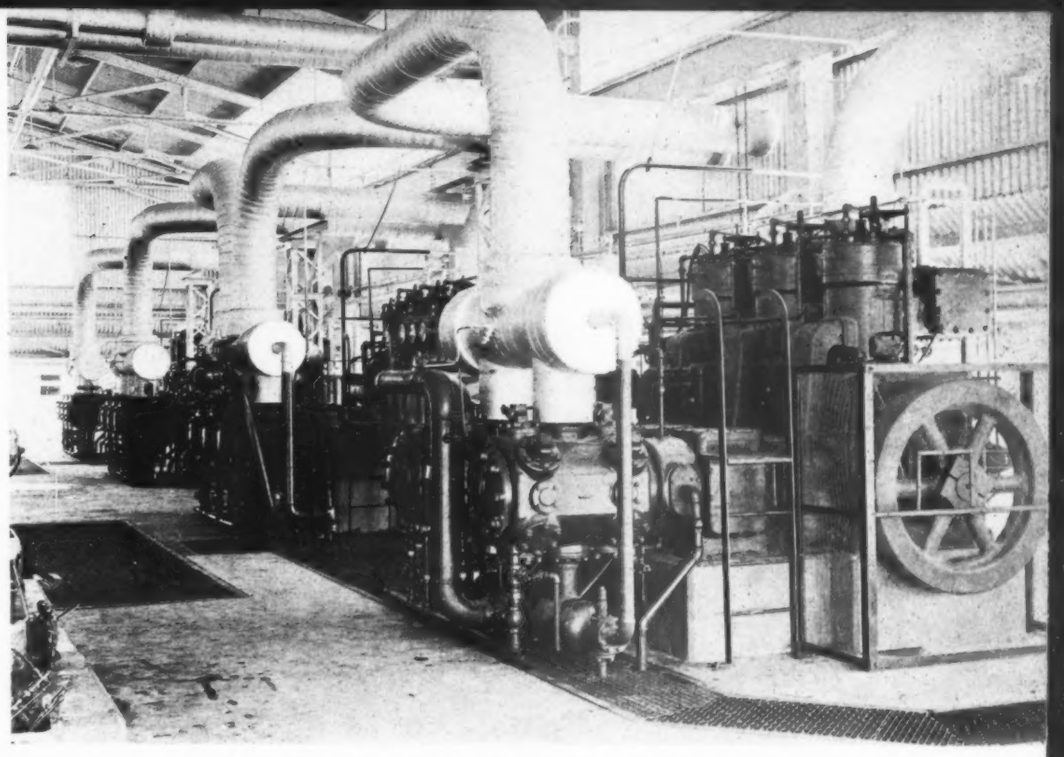
In the Unitary Process employed, propanes and butanes are cracked and polymerized simultaneously in a coil at a temperature of about 1025 deg. F. and a pressure of 1800 lbs. per sq. in. at the coil outlet. Similar units of smaller capacity have been operated by the Phillips Petroleum Company for a number of years. The unit proper, exclusive of auxiliary equipment to prepare and handle the feed stocks, cost about $2,000,000 within battery limits. The unit was constructed by the M. W. Kellogg Company from designs prepared jointly by the Standard Oil Development Company and the M. W. Kellogg Company, under patents held by the Polymerization Process Corporation. A general view of the unit is shown above.

About 4,000 bbl. per day of butane-butylene mixture, recovered from refinery operations, and 4,000-6,000 bbl. per day of butanes recovered in the East Texas field and transported to Baytown by pipeline in a casinghead blend, constitute the feed to the unit. The field butane mixture is first rectified into iso and normal fractions. Of the normal butane thus segregated, a maximum amount, as limited by vapor pressure specifications, is blended into gasoline, and the remainder, about 3,000 bbl. per day, is included in the charge to the polymerization unit. Field isobutane constitutes the remainder of the charge. It should be pointed out that the aforementioned figures are estimated average values and hence only approximate, as seasonal variations in the quantity of butanes available from East Texas, and in the amounts utilizable in gasolines, will cause substantial deviations in operations from those

outlined above. At times when there is an insufficient supply of butanes to operate the unit at capacity, subsantially all of the propane ordinarly discarded in the polymerization unit residue gas can be recycled, thereby increasing the percent yield of gasoline per barrel of fresh feed; if further capacity is available, propane, either from the East Texas field or recovered from refinery gases, may be included in the fresh feed. Indications are, however, that sufficient butanes will usually be available as fresh feed so that only the minimum amount of propane will be recycled prior to the completion of the contemplated expansion program.

FLOW

The principal features of the thermal polymerization unit are shown in the flow diagram, on page 47. Fresh feed is direct-contacted in the furnace feed stripper, leaving with recycled butane and propane as essentially methane and ethane free bottoms, which are pumped to the furnace through transfer line heat exchangers countercurrent to the furnace outlet stream.



Thermal polymerization plant, Humble Oil and Refining Company, Baytown, Texas, shown on facing page, and above: Four Clark Brothers 300 h.p. super 2-cycle gas engine driven propane refrigeration compressors equipped with automatic volume control.

TABLE I

Typical Operating Conditions of Thermal Polymerization Unit

	Temperature deg. F.	Pressure, Lbs./Sq. In. Ga.
Rates of Flow		
Fresh Feed, B/D		8,000 — 10,000
Furnace Feed, B/D		28,000 — 35,000
Light Polymer Gasoline, B/D		2,350 — 2,500
Heavy Polymer Gasoline, 400 deg. F. E.P., B/D		850 — 950
Gas Oil and Tar, B/D		250 — 300
Residue Gas, C.F./D (@ 60 deg. F. & 1 atm.)		11,000,000-13,000,000
Temperatures and Pressures		
Furnace Inlet Stream		
Furnace Charge Pump Discharge	140	1950
Furnace Inlet	600-620	....
FURNACE OUTLET STREAM		
Radiant Section Outlet	995-1005	....
Soaking Section Outlet	1000-1025	1700
Outlet Transfer Line Exchangers	325-400	1300
PRIMARY TOWER		
Overhead	190-210	360-400
Reboilers	400-500	360-400
GASOLINE TOWER		
Overhead	165	0
Bottom	300-400	0
FURNACE FEED STRIPPER		
Overhead	135	340-380
Reboilers	200-210	340-380
RECOVERY TOWER		
Overhead	58-70	320-360
Bottoms	85-90	320-360
Reflux	-7-30	320-360

The partially cracked and polymerized furnace discharge or transfer line stream, after being cooled by heat transfer in exchangers and by addition of heavy recirculated quench oil, enters the 400 lb. primary rectification tower, from which an essentially pentane free overhead stream, consisting of butanes and lighter fractions, and a partially debutanized bottoms stream, are withdrawn. The latter stream is separated into a light gasoline (230 to 250 deg. F. end point), a heavy naphtha (400 deg. F. end point), and a mixture of quench oil and heavy tarry bottoms, in the low (atmospheric) pressure gasoline tower. A portion of the gasoline tower bottoms is recirculated as quench oil and the remainder withdrawn from the unit and replaced by clean heavy gas oil make-up. The overhead stream from the primary tower, combined with the fresh feed, goes into the furnace feed stripping tower, in which a split is made between the furnace feed, which leaves the tower as a bottoms stream, and the lighter fractions, which are removed overhead. All of the butanes, and that portion of the propane which is to be recycled, are recovered in the small recovery tower and its refrigerated partial condenser and refluxed to the furnace feed stripper. The uncondensed vapors leaving the refrigerated partial condenser form the residue gas from the unit and pass to the refinery fuel gas system. Typical operating conditions are listed in Table I.

FURNACE

The furnace which is fired with part of the polymerization plant residue gas, was designed to heat 27,600 bbl. per day, but normally heats 37,000 bbl. per day of furnace feed from 625 deg. F. to 1025 deg. F. The total heat liberated, on the basis of design conditions, is 132,000,000 B.t.u. per hour, of which 81,000,000 B.t.u. per hour is absorbed by the furnace feed stream (6,400,000 B.t.u. per hour as heat of reaction), the corresponding furnace efficiency being 61 percent. The preheater and radiant sections contain 7,140 sq. ft. of outside tube surface, and the soaking section, which is in a separate setting and heated with flue gases only, contains 13,448 sq. ft. All tubes are 40 ft. long; those in the main furnace have an O.D. of 5-in. and a wall thickness of $\frac{3}{4}$ in., whereas those in the soaking section have an O.D. of 5-$\frac{1}{2}$ in., and a wall thickness of $\frac{5}{16}$-in. All tubes, other than the steel tubes in the first part of the preheater, are of a two percent chrome, and half percent moly composition. The tubes are rolled into the headers.

The flow through the main part of the furnace is in four parallel paths, each designed to have the same heat pick-up. Each of these four paths is made up of passes of two tubes in parallel, four-way Kellogg type header boxes being used. On entering the soaking section, each stream is divided, making eight parallel paths in this section. Sixteen burners, operating with forced draft, are used. The arrangement of the heating surface, burners, and flow of combustion gases is shown on page 46.

The furnace and soaker were designed to give a time-temperature relationship sufficient to effect a 16.7 percent (by weight) conversion per pass to polymer liquid (gasoline + gas oil + tar) when charging a fresh feed consisting of 15 percent (by weight) butylenes, 20 percent isobutane and 65 percent n-butane, recycling substantially all propane formed, and operating at a soaker outlet temperature of 1025 deg. F. and pressure of 1600 lbs. per sq. in. For a given soaker outlet temperature, the conversion per pass depends on the composi-

tion of the furnace feed, which in turn depends on the fresh feed composition and the amount of propane recycled.

PUMPS

The furnace charge is handled by two single-stage, double-acting, five cylinder pumps, operating in parallel, each driven by a horizontal gas engine. Each of these pumps is designed to handle a maximum of 21,600 bbl. per day of furnace feed at 150 deg. F., raising the pressure from 385 lbs. per sq. in. to 2,100 lbs. per sq. in. The plungers are 4½ in. in diameter with a 24 in. stroke.

The highly efficient gas engines, which drive the furnace feed pumps, are single-tandem, horizontal, four-cycle, and double-acting, with a 26 in. bore and 36 in. stroke. The rated brake horsepower is 825 at 138 r.p.m. These engines are now being operated on sulphur-free natural gas having a heating value of about 1,000 B.t.u. per cu. ft. These engines are separated from the pumps by a brick wall as a safety precaution.

RECOVERY

In order to recover substantially all of the propane from the residue gas, temperatures as low as —7 deg. F. are required (at approximately 400 lbs. pressure), and for this purpose a closed refrigeration system using propane as a refrigerant has been provided. This system furnishes refrigeration for the operation of a partial condenser for the recovery tower overhead, providing a low temperature for the equilibrium mixture of residue gas and recovery tower reflux. However, thus far it has usually been desirable to recover only a portion of the propane, and therefore the refrigeration system has normally operated at a load only sufficient to reduce the temperature of the stream leaving the partial condenser to 10-30 deg. F.

The compressors on the refrigeration system consist of four 300 H.P. angle gas engine driven compressor units; the refrigeration system being split into two levels. The high level consists of two 300 H.P. units, each having a capacity of 15,000 lbs. of propane per hour operating with a suction pressure of 40 lbs. per sq. in. absolute and discharge pressure of 240 lbs. absolute. Intake temperature is 15 deg. F. and discharge temperature is 115 deg. F.

TABLE II

Description of Transfer Line Exchangers

Heat Duty, B.t.u./hour	84,170,000
Average Transfer Rate, B.t.u./hr./sq. ft./degrees delta T	180
Total Surface, Sq. Ft.	2,920
Number of Sections	8

DESCRIPTIONS OF SECTIONS

Shells (Furnace Inlet Stream)
4 in series, connected by return bends; seamless steel; O.D. 8.15 in., wall thickness 11/16 in.

Tubes (Furnace Outlet Stream)
16-4 in parallel in each shell, connected in series by return bends so as to have strictly counter-current flow between furnace inlet and outlet streams; carbon steel; O.D. 2⅜ in., wall thickness ¼ in.; length, 2 sections next to furnace, 30 ft., 6 remaining sections, 40 ft.

There is one 300 H.P. compressor operating on the low level with a capacity of 11,400 lbs. per hour operating at 26 lbs. per sq. in. absolute suction and 240 lbs. absolute discharge; the suction temperature is zero and the discharge temperature is 123 deg. F.

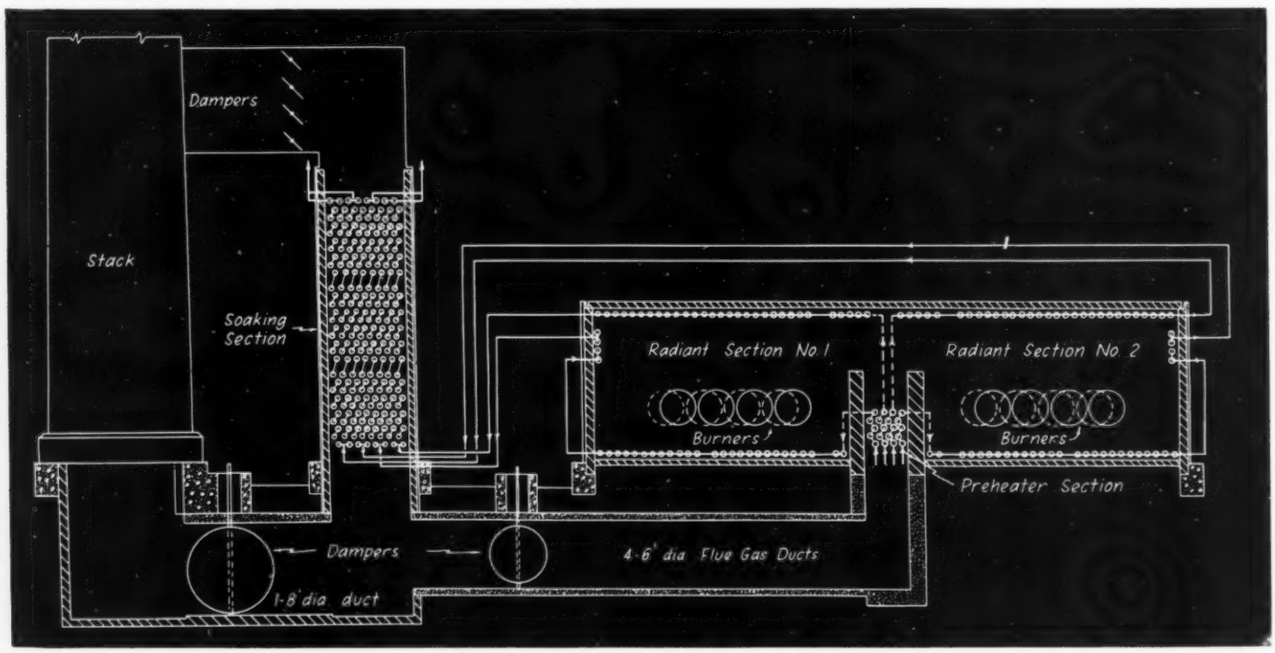
The fourth unit is a spare unit for either of the above machines and by operation of special clearance control, this unit may be used on either the high or low level service. The refrigeration requirements are automatically controlled by changing the compressor capacity with specially designed port valves and clearance pockets.

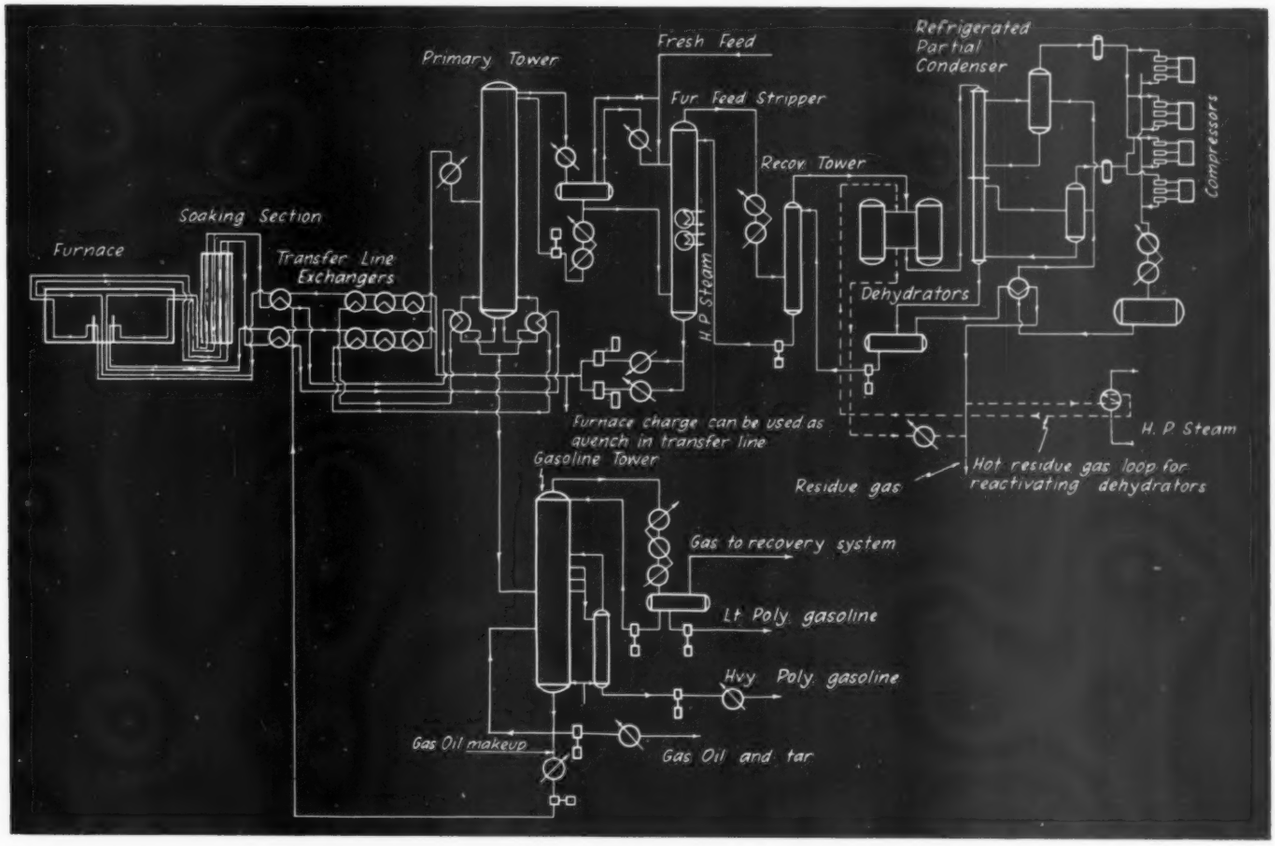
By splitting the refrigeration load into high and low level, considerable horsepower is saved by taking advantage of the high suction pressure at the high level condition.

In order to avoid the possibility of restricting flow through the refrigerated partial condenser by hydrocarbon hydrate formation or icing, arising from moisture in the recovery tower overhead, alumina gel drying equipment has been installed ahead of the condenser. Two dehydrators are provided so that one may be reactivated while the other is being used. Reactivation is carried out by circulating heated dry residue gas through the dehydrator which is then cooled with cold dry residue gas.

EXCHANGERS

Transfer line heat exchangers, designed to transfer an amount of heat to the furnace feed equal to that added in the furnace, are a special feature of the polymerization unit. The arrangement of these high temperature, high pressure, high velocity exchangers, which were designed for an average transfer rate of 180 B.t.u. per hour per sq. ft. per deg. F. temperature difference, is shown on page 47, and specifications are presented in Table II. Essentially, these exchangers consist of 8.15 in. O.D. tubes, which constitute shells, containing four parallel 2⅜ in. O.D. tubes. The flow is strictly countercurrent, the furnace discharge stream





flowing inside the tubes to facilitate cleaning, and the furnace feed stream on the outside.

OPERATION

As to be expected, numerous mechanical and operating difficulties were encountered in the initial operations; none of the first twelve runs lasted more than ten days. Coil coking, due to soaker circuit channelling, corrosion of furnace charge pump plungers, and packing leakage were corrected respectively by flow rearrangement, replacement of cast iron plungers with alloy steel plungers, and use of a different type of packing. Transfer line coking troubles were reduced by use of quenching oil. Four runs were terminated by leakage of the soaker headers, and this leakage was finally eliminated by welding of the headers to the tubes.

Average Overall Rates for Trial Runs

	Run 13	Run 14
Fresh Feed Charged—bbl. per day	6,205	7,120
Gasoline Produced	2,582	2,940
Light Naphtha—bbl. per day	1,926	2,186
Heavy Naphtha—bbl. per day	656	754
Residue Gas—Cu. ft./day	8,830,000	10,700,000
Furnace Throughput—bbl. per day	29,180	29,700
Conversion per pass—Wt. percent	12.6	13.8

After removal of the aforementioned difficulties, one 30-day run and one 43-day run were made, both runs being deliberately terminated for header inspections. In both cases the header welds were found to be in good condition.

An experimental program to determine equipment limitations and indicate supplementary equipment requirements is now in progress. It is hoped that installation of one or two new bubble towers and pumps, rearrangement of existing exchangers, and addition of new surface where necessary, will permit operation of the unit at furnace charge rates as high as 40,000 bbl. per day and conversions per pass as high as 16 percent by weight.

PRODUCTS

The light polymer gasoline, which is the principal product from the operation, normally has a 13.0 lb. R.V.P. and an octane number (C.F.R. Motor Method) blending value of about 87 in a 30 percent mixture with 65 octane number reference fuel. Typical tests on products, together with light hydrocarbon analyses of fresh feed, furnace feed and residue gas are shown in Table III.

Since the light polymer gasoline is of good color and color stability, and is free from mercaptans and elementary sulphur, it is blended directly into finished gasoline without treatment of any sort. The heavier, 400 E.P. polymer gasoline is of unsatisfactory color, and is therefore, mixed with the cracked naphtha produced from conventional thermal cracking units, and receives a light (1.5 lb. per bbl.) acid treatment. The treated naphtha is then redistilled to a six percent bottom, and doctor sweetened.

CONCLUSION

In conclusion it may be stated that operation of the Baytown thermal polymerization unit has demonstrated the practicability of high capacity units employing the Unitary Polymerization Process. While initial operations have been impaired by a number of mechanical and operating difficulties, most of these have been overcome, and present operations appear sufficiently attractive to warrant increasing unit capacity by proper addition of supplementary equipment.

TABLE III

Typical Tests on Products and Feed

	Light Polymer Gasoline	Heavy Polymer Gasoline	Gas Oil and Tar
Gravity, deg. API	75	44	20
I. B. P., deg. F.	90	195	370
F. B. P., deg. F.	245	450	90% @ 660°F.
% @ 158 deg. F.	58	....	....
% @ 212 deg. F.	95	2-3	....
R.V.P., Lbs. Sq. In.	13	2-3	....
O.N., C.F.R. (clear)	77.5	75.0	....
O.N., C.F.R. (blending value*)	87.0	....	....

*When blended to a 30 percent mixture with 65 O.N. reference fuel.

Mol. Percent	Fresh Feed	Furnace Feed	Residue Gas
C_1	....	....	51.0
C_2	....	1.5	28.0
C_3	....	10.5	19.5
i-C_4	20.0	30.0	1.5
n-C_4	80.0	58.0	
Total	100.0	100.0	100.0
Unsaturates	15.0	14.0	12.0

THERMAL POLYMERIZATION PLANTS ECONOMICALLY PROCESS A WIDE RANGE OF GASEOUS HYDROCARBONS

The charging stock for Kellogg-built thermal polymerization plants can consist of either saturated or unsaturated gaseous hydrocarbons—or both.

The operation of such units is simple, this wide range of charging stocks being handled without change in equipment.

Thus, new sources of profitable products are opened to refiners and natural gas plant operators through the processing of waste gases, or gases now considered of low commercial value, into high grade blending gasoline and other products, such as aromatic solvents and other organic derivatives.

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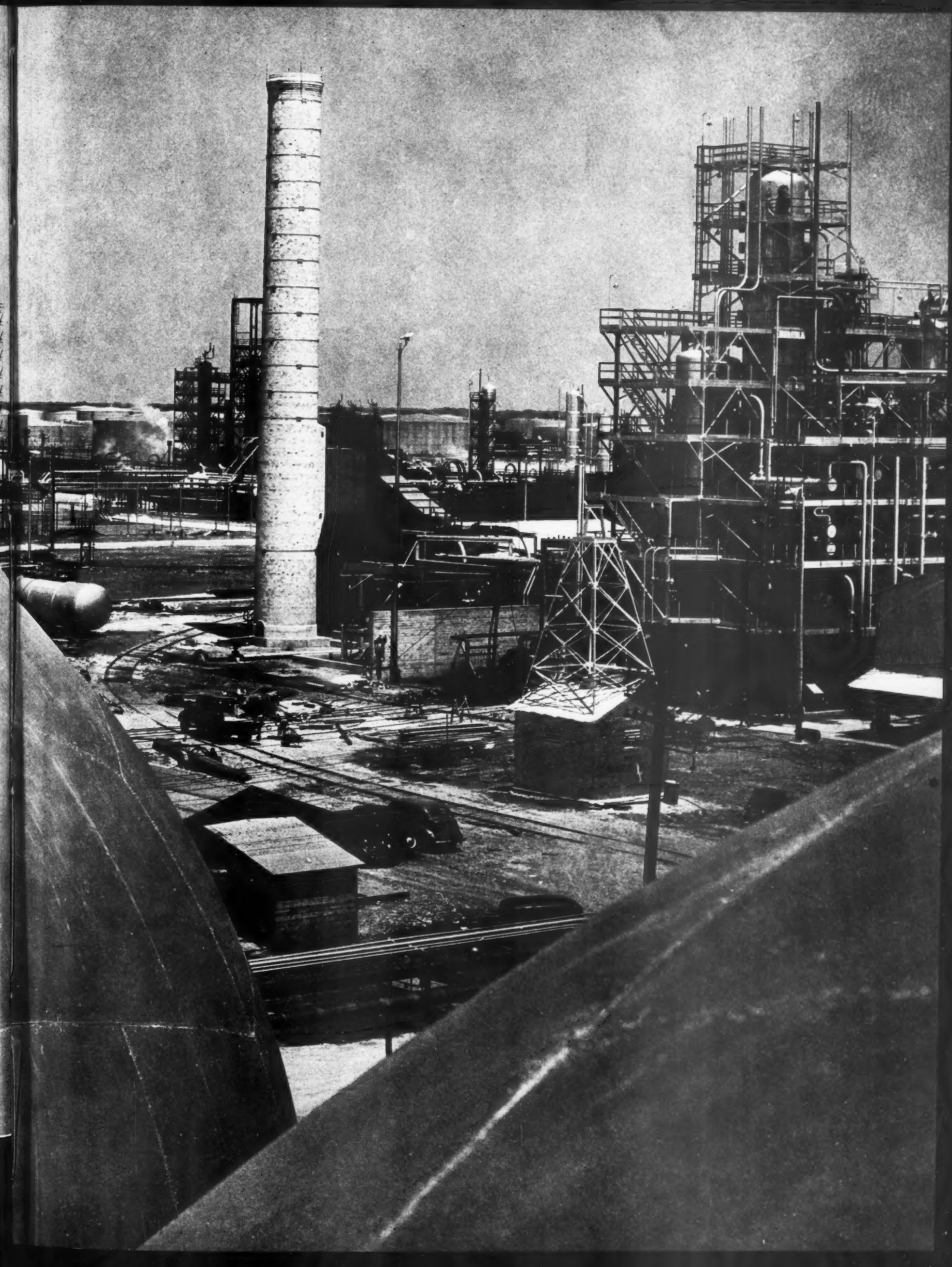
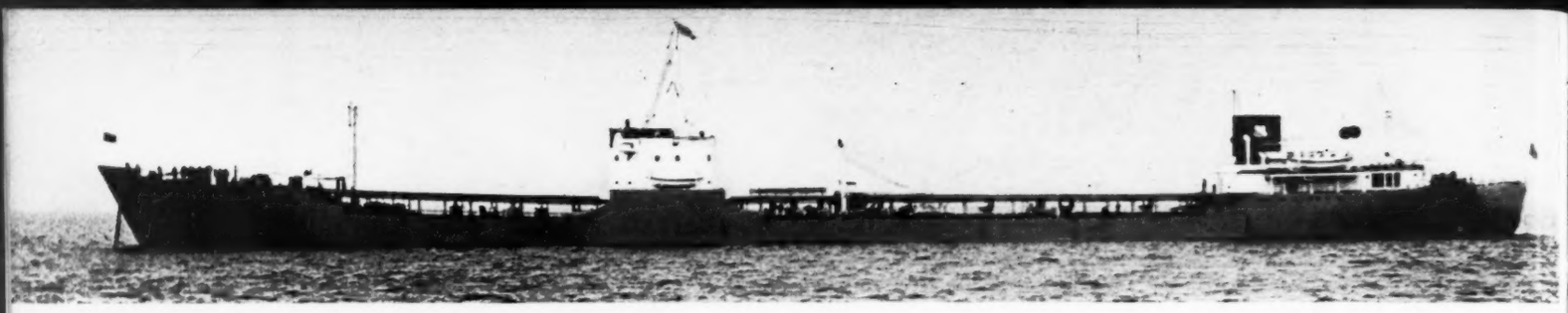




Tankers with patent hull forms and streamlined superstructure are increasing in popularity with Scandinavian owners.

Outlook For Future Tanker CONSTRUCTION

By Robert W. Morrell
Cons. Naval Architect

Bright Prospects for Continuation of Present Demand for Tonnage —Naval Architect Discusses Economics of Propulsion Types and Shows Differential Between British and American Building Costs Has Been Halved—Need for Standardization Emphasized.

VIEWING the prospects for future tanker construction, it seems evident that the placing of new tonnage will be governed by the following major considerations: (1) age or obsolescence of tankers now in service; (2) naval requirements; (3) trend of shipbuilding prices; (4) existing demand and prospective requirements for tanker tonnage in the transportation of oil, governed by consumption and location of oilfields and refineries in relation to the markets.

It must be remembered that the effective economic life of a tanker is an indefinite period. It represents the time during which the vessel has some vestige of earning capacity, at the end of which deterioration is such that necessary renewals, replacements and maintenance are no longer justifiable. The extent of such period is affected by the original quality of design, material and workmanship, by the nature of the service in which the vessel has engaged, by the degree of upkeep which has been maintained and by the current market for tanker tonnage as reflected in charter rates and in shipyard prices.

No one can generalize by fixing an arbitrary number of years as the life of all tankers. A tanker engaged exclusively in the gasoline trade might have a life of 12 years or less. An average for tankers in general would be 20 years, although some tankers have been in operation over 25 years. After 20 years overhaul charges generally become uneconomical.

Perfection of electric welding methods has done much to prolong the usefulness of certain tankers. Whether the future life of welded tankers will be longer than has been the case with riveted hulls, remains to be seen. It probably will be so, to a limited extent. Welded construction will obviate the expensive renewal of rivets in old hulls and, while it cannot stop the corrosion of the plates and shapes, it affords convenient means of avoiding or postponing their renewal by direct building-up of welding material to offset localized corrosion, or by welding on patches to reinforce thin members.

Obsolescence of design, as distinct from physical deterioration, is another matter. Economic life of a tanker is affected by the rapidity of advance in increased speed and improved metallurgy. Rapid strides in efficiency of hull design (Arcform, Maierform, etc.) and development of high pressure and temperature steam propelling installations and of marine Diesel and electrical machinery, make the older vessels no longer able to compete with their fast, modern sisters. This has been true, and will be true to an increasing extent. Marine machinery design lags somewhat behind the advances in shore power plants, but the latter point the way to progress.

From the reports of the U.S. Department of Commerce, it appears that there now exist 327 American tankers, of 2,383,540 gross tons which are not more than 22 years old. Of this total sea-going tanker fleet, 280,000 gross tons or about 11.7 percent are over 20 years old; 1,917,650 gross tons or about 80 percent are over 15 years old; and 1,948,630 or nearly 82 percent are over 12 years old.

The significance of these figures from the standpoint of obsolescence is almost appalling. Taking into consideration the 287,500 gross tons now in hand but not delivered, which are not included in the above, it will be necessary for America to build, in the next five years, an additional 1,320,000 gross tons of replacements in order to maintain the present age level. This represents an average of 264,000 gross tons per year. When it is considered that the years 1936 and 1937, which were regarded as fairly active in tankship construction in American yards, saw the completion of about 70,180 and 91,940 gross tons respectively, the magnitude of the problem is apparent. The task is by no means impossible from a shipbuilding standpoint, for in 1921 American shipyards turned out 677,341 gross tons of tankers.

Comment overseas seems to recognize the need of extensive replacements of European tanker tonnage also, and the large volume of production abroad seems to be looked upon in this light. It is pointed out that many European contracts are for long-term delivery.

The next factor in considering prospective tanker construction is that of naval requirements, but this is only a small part of the replacement picture and the problem remains essentially industrial rather than naval.

PURCHASING

It is well-known that prices for tankship tonnage have always been referred to on the basis of price per deadweight ton. But even this seemingly standard unit of comparison is becoming increasingly complicated by a number of variables.

Up to about 1925, tanker design was well standardized with respect to speed and propulsion, the preponderance of the ships being equipped with reciprocating engines and Scotch boilers for a sea speed of 9 to 10 knots. In this respect, the construction prices existing then had a common denominator. More recently the general increase in tanker speed to about 13 knots,

Bolting plates on a new German tanker prior to rivetting.

with correspondingly increased power and the abandonment of reciprocating machinery and Scotch boilers in favor of geared-turbine drive with water-tube boilers and high steam pressure and temperature or in favor of direct Diesel, geared-Diesel, turbo-electric and Diesel-electric types of drive, has caused the unit price per deadweight ton to mean something quite different. This transition must be kept in mind when comparing old and new prices.

Consideration must be given to the more expensive and elaborate equipment and fittings of the modern ships. Living quarters are now more commodious and are of fireproof construction. Safety devices have been improved, such as in smothering equipment, mechanical ventilation, and explosion-proof electrical machinery. Cargo pumping facilities have been improved, with marked increase in the rate of discharge in recent tankers, and provision for handling separate grades of oil. Refinement in design of propeller and rudder equipment in auxiliaries and navigational features have been quite noticeable. Tank cleaning apparatus and vapor-recovery devices have been incorporated.

Thus there has been a definite trend toward paying more in first cost in the interests of greater safety and efficiency in operation, and this is reflected in the price per deadweight ton.

The influence of electric welding in tanker construction has not been particularly noticeable in the recent contract prices. For tank barges and small work, welding has proven definitely cheaper than riveted construction, but for the large types, although there is a real reduction in steel weight, the reduction in price per deadweight ton in welded hulls has not been evident.

Application of welding on this large scale has been going through a somewhat preliminary stage, involving some revision of shipyard methods and technique. Increased experience in welding will undoubtedly permit of better costs and prices for welded work, the future of which is assured.

Size of the ship affects any comparision of the unit price per deadweight ton. A tanker of 16,000 tons deadweight used to cost about 10 percent less per ton than one of 10,000 tons, built at the same yard at the same time. This was true in the old days, when both ships were built for the same slow speed of 9½ knots at sea. As the designed speed of both increases this differential is partially offset by the fact that the smaller ship, to equal the speed of the larger, must have relatively more power. There is little indication of any definite trend toward increased deadweight per ship, although the most recent American contracts, involving 14 ships exceeding 16,000 tons each, are well above the average. The tankers built since 1917 averaged about 11,600 tons, deadweight, while the 11 built in 1937 average 13,200 tons. Larger individual tankers have been built in previous years than any in the current program. It must be remembered, too, that the fast modern ships require greater overall dimensions for a given deadweight capacity than did the slow tankers of past years. Size of tankers is governed, to some extent, by the draft of water permitted at the various ports of loading and discharge. The load drafts of the tankers recently built and now building, of commercial design, range from 27 ft. 6 in. to 30 ft. 2 in. About two-thirds of them are of 28 ft. 4 in. draft or less. This draft limits the deadweight to about 13,000 tons, for normal design.

Returning to the subject of price per ton deadweight, a third factor in considering relative figure is that of duplication, or standardization. A shipyard can build two, three, four or more sister ships at a lower price per ton than for one ship. So that in comparing unit prices, consideration must be given to whether they represent contracts for single ships or for groups of sister ships. Proper analysis would require the prices to be converted to a common basis. If a price is quoted for two duplicate ships, the price of one would be about six percent more, per ton; if for three, one would be about 10 percent more; if for four, 12 percent. These are subject to variation.

European tanker construction has been standardized much more extensively than in the United States, and their features of design are less elaborate. This fact should be kept in mind when comparing American and foreign tonnage prices for tankers.

With these variables in mind, speed, modern equipment, size and duplication,

Courtesy Pennsylvania Shipyards

Paratex—new 20,000 bbl. coastwise, river and canal tank barge of Gulf Oil Corporation.

it is possible to review the price trends in America and abroad.

PRICE RATIO

In the United States, pre-war tanker prices were $65 (£13)* to $70 (£14) per ton deadweight, which increased to about $200 (£40) by 1919. In 1922 they were down to an average of around $110. (£22) From then until about 1929 was a very slack period, with only occasional contracts, and prices as low as $105 (£21) per ton. In 1930, 11 American tankers were delivered, and construction then fell off until 1935 which saw the beginning of a revival in tanker building in that country, with prices for 12 to 13 knot geared-turbine drive ships at about $120 (£24) per ton. Both the volume and the prices have been increasing ever since, until the price level today is fairly well established at $140 (£28) per ton deadweight for 13-knot tank steamers.

In 1936, the Government estimate for proposed 15-knot tankers of 6,600 tons deadweight was $154.69 (£29) per ton, as compared with about $128 (£26) per ton for commercial tankers of 13 knots at that time. Contract price for the 12 new 16½-knot tankers is $37,556,004 (£7,511,200), which amounts to about $191.50 (£38) per ton deadweight. Of this the government is to pay $10,563,000 (£2,112,600), for the special features so the ships will cost the oil companies just over $137 (£27) per ton, which is in line with current prices for 13-knot tankers. The speed at which they will be operated commercially is problematical. It will be influenced by the efficiency curve of the machinery at part load, by the companies' bulk shipment requirements, and by the condition of the charter markets—all of which present an interesting and highly scientific problem of tanker operation. Upkeep of these high-powered tankers will be greater than for normal ships.

The increase in U. S. tanker prices for geared-turbine drive from $120 (£24) up to $140 (£28) per ton has been due partly to refinements in design and equipment and partly to increased labor rates.

With reference to prices for Diesel tankers in the United States authentic information is very scarce; but they are believed to run about five percent higher than for steam propulsion, per ton deadweight of ship.

Price per deadweight ton presents a different conception when applied to Diesel-driven tankers than when referring to tank steamers. Total deadweight-carrying capacity consists of the principal items of cargo, bunker fuel, fresh water, lubricating oil, and stores. For reasonably definite service requirements, an owner is more interested in the quantity of cargo a ship will carry, or the net-cargo deadweight, than in the total deadweight. The weight of bunkers for a given voyage is less in a motorship than in a steamer; and for a long voyage, this difference amounts to a considerable item. So that to carry a given cargo a given distance at a given speed, a tank steamer would need to have greater total deadweight, and larger dimensions, than would a motor tanker. Hence, when comparing the costs of a vessel to be equipped with either Diesel or steam machinery figuring should be done on a net-cargo capacity ton as well as on a deadweight capacity ton basis. When a motorship and a steamship have the same deadweight capacities, the Diesel vessel has a greater cargo capacity, so to all practical purposes is an appreciably larger tanker.

H. Gerrish Smith, president of the Council of American Shipbuilders, has pointed out that in addition to more exacting specification requirements, shipyard labor rates have advanced until they are at least 10 percent higher than war-time labor rates were.

He also called attention to increases in prices of shipbuilding materials, citing figures of the Bureau of Labor Statistics which compare levels of late 1937 with

*Approximate equivalents are given in brackets.

those of early 1933. These show increases from 21.4 percent for paint materials, and 32.7 percent for iron and steel products, to 100 percent for non-ferrous metals.

European prices, which all seemed to be based on 12 knot Diesel tankers of 12,000 tons deadweight, were reported to be at £11 to £12 ($55-60) per ton from 1930 through 1935, but rose above £14 ($70) during 1936. A 15 percent increase in British prices was reported between March and July, 1937, and the current price seems to be about £19 ($95). The price rise abroad was accompanied by a tremendous volume of production. Comment has indicated that the tendency was to place contracts before prices went up too high, but for long-term deliveries. It was reported in June, 1937, that British interests were making inquiries looking toward tanker construction in America, and it seems probable that the activity abroad may have resulted in American oil companies placing domestic contracts which might otherwise have gone to other yards.

By comparison, prices in this the U.S.A., although apparently about 100 percent above the prices abroad in 1930, are only about 50 percent higher now.

A wide differential has always existed between shipyard costs in America and abroad, largely due to the higher wage scale in that country. Another important reason for this discrepancy is that element of standardization both as to hull and machinery, which exists in European yards.

STANDARDIZATION

Construction of tankships in Europe has also represented an outstanding aspect of current shipbuilding. The large-scale activity has resulted in an extensive degree of standardization; not only for contracts placed by the same owners, but for ships of different companies.

Standardization of types in the United States has not reached any such proportion. The greatest number of identical ships ordered recently in America is the 12 fast tankers and only three of these are being built in any one yard. Federal shipbuilding Company has developed a 13,000 ton type for Jersey Standard and Pan American, of which 10 ships have been or are being built. These are not identical, but have the same general characteristics. Gulf Oil Corporation has built six ships, practically sisters, in two different yards. The Bethlehem Plant at Sparrows Point has had five similar ships under construction, of the Frear-Bethlehem design; four for Standard Oil of New Jersey and one for The Texas Corporation. A sixth, just placed by Union Oil Company, is believed to be also of this design. The Sun yard has had five ships, quite similar; two for Standard of New Jersey, two for Standard of California, and one for Bernuth-Lembcke Company. Sun has also built three motor tankers for Texas, sister ships. Socony-Vacuum Oil Company built the MOBILOIL and MOBILGAS at Sun, and now have two similar vessels in hand at Sparrows Point.

On the other hand, three single ships have been ordered, unlike any others; namely, two motor tankers for Sun Oil Company and a steamer for Tide Water Associated. The greatest diversification in types has been at the Sun plant, which has had the following different orders in hand since the latter part of 1936:

2 of	11,400	tons	D.W. each, for	Gulf
2 of	15,400	"	" "	Pan American
2 of	15,500	"	" "	Socony-Vacuum
1 of	15,800	"	" "	Sun Oil (Diesel)
2 of	18,500	"	" "	Atlantic Refining
5 of	13,000	"	" "	S. O. C. of N.J., S. O. C. of Cal., and Bernuth-Lembcke.
3 of	12,400	"	" "	Texas Corp. (Diesel)
1 of	18,360	"	" "	Sun Oil (Diesel)
1 of	11,900	"	" "	Tide Water
3 of	16,300	"	" "	S. O. C. of N.J. (18-knot)

From the standpoint of propelling machinery, the standardization has been rather more complete than it was in the hulls. The boilers for all the new tank steamers have been either Foster-Wheeler A or D types or of Babcock and Wilcox make. Turbine orders have been divided among Westinghouse, General Electric, DeLaval, Allis-Chalmers and Bethlehem. Reduction gears have been furnished by Farrel-Birmingham and Falk. The motorships have all had the Sun-Doxford, 2-cycle,

Tanker off Rhenania-Ossag installation, Hamburg.

Bralanta, 14,500 ton deadweight tanker of Ludv. G. Braathen, Oslo, will be followed by a sister ship now building.

Courtesy Maierform of America Inc.

opposed-piston, direct-reversing type of Diesel.

It is evident that standardization in tanker construction in America has not reached anything like the degree developed abroad; and this fact is believed to have a real influence in the price differential.

This one feature is also considered to be a controlling factor in the selection of propelling machinery, and to account, in a large measure, for the fact that practically 90 percent of the new European tankers are Diesel-driven, while in the United States the percentage is less than 16. Another factor is that European tankers, in general, are operated on longer trade-routes than are the American ships; and the motorship is at its best on long voyages.

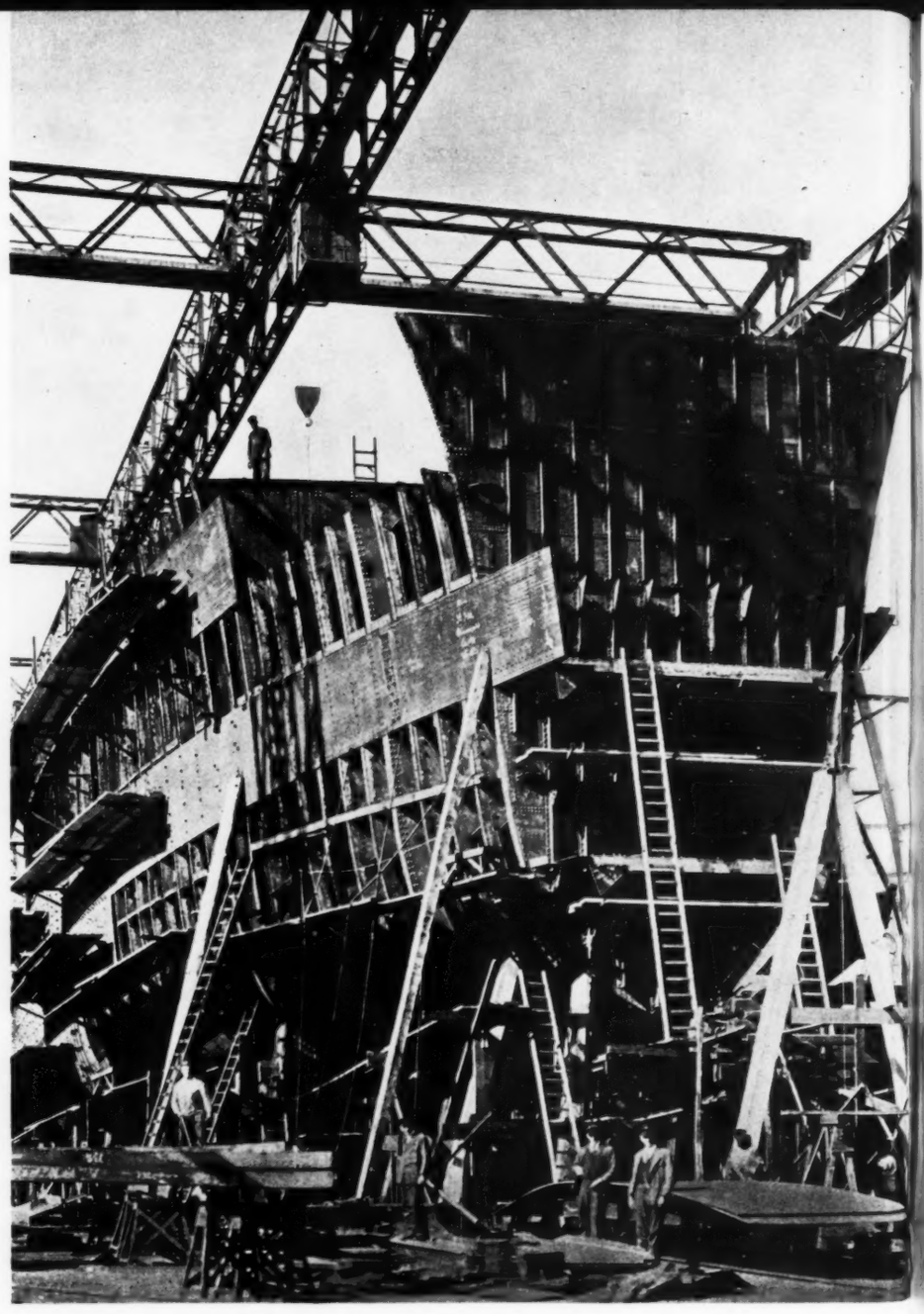
FUTURE REQUIREMENTS

Considering now the question of probable future tanker tonnage requirements, a definite long-range building program is necessary to take care of obsolescence and to maintain the existing tonnage level. This naturally raises the question of whether the volume of tanker tonnage currently available is going to be needed throughout the coming years, whether less volume will suffice, or whether the demand for tanker bottoms will increase, in order to meet the needs of prospective water-borne transportation of oil. It involves consideration of probable future petroleum production, consumption, and transportation—every indication points to increased activity in all three directions. Oil production has shown an average annual increase of eight percent through the last half-century, and the world production of crude oil in 1937 exceeded the 1936 output by 13.4 percent representing 231,000,000 bbl., and this had to be transported in both crude and refined state.

American production increased 16.5 percent for the year.

Consumption of petroleum and its products has increased correspondingly; in fact the consumption, or demand, usually governs the production. In the United States, which is producing 62 percent of the world output of crude, the gasoline consumption for 1937 was 9.5 percent higher than in 1936, and the consumption of all oils was 10 percent higher.

Likewise, marine transportation of oil has been steadily increasing and is expected to continue to increase. However, when this is considered in terms of ton miles, it shows some fluctuation. It is affected by occasional shifting of production and refining centers, with consequent realignment of trade routes. The tendency to establish refineries near the source of production tends to reduce the volume of crude shipments by water and correspondingly to increase the volume of cargoes of refined products, often to quite different ports than originally. Opening of new oilfields, and the changing nationalistic, industrial and tariff policies of governments, likewise affect the marine transport of oil.



Germany has more tankers building than any other country in the world—42 aggregating 594,000 tons deadweight. Half are for American owners.

Predictions are for further increase in marine transportation of oil. Developments in the Near, Middle and Far East indicate that these areas are likely to produce a much greater proportion of world output in the next few years than at present, possibly amounting to a major transition. This would involve a much longer haul by water, for part of it, at least. There is also a tendency in some countries toward the construction of their own refineries, probably in line with a policy of becoming self-contained. Conversely to the condition stated before, this tends to increase the shipments of crude oil. Even the situation in Mexico is a factor which may tend to affect tanker movements.

The tanker charter market is characteristically so variable and fluctuating that it is unwise to extend its curve into the future. It was affected by conditions in the Mediterranean and by shipments to Japan. The tone of comment abroad shows satisfaction with operations in 1937, and little anxiety is caused by the large volume of tanker deliveries from European shipyards.

In considering tanker tonnage, the requirements should not be expressed in terms of tonnage alone, but rather in ton-miles. Each year, the tanker fleet must move a given quantity of oil a certain number of miles, from port to port. The faster the

Courtesy Boletin de Informaciones Petroleras

Comodoro Rivadavia oilfield, Argentina, with the Y.P.F.'s 10,500 ton tanker 13 de Diciembre loading in the foreground—Y.P.F. has a fleet of tankers totalling about 86,500 tons deadweight and a further large vessel is completing in Germany.

ships, the more oil they can carry in the year. The faster the ships, the less in number or tonnage are required to move the given quantity the given distance in the year. This is roughly proportional, inversely, to the sea speed, for ships of the same deadweight capacity, but not exactly so; because the greater fuel consumption for high speed reduced the cargo capacity on a given deadweight. This, of course, is more apparent on long voyages.

For a given trade, the effect of increased speed upon deadweight tonnage requirements can be figured quite definitely. For world-wide trade, it is only possible to generalize by saying that, for a given annual ton-mile requirement, less tonnage is needed if the ships are fast than if they are slow.

In summarizing the foregoing analysis of tanker construction, the following conclusions seem to be outstanding, in the writer's opinion: (1.) The need for tanker replacements to offset obsolescence is urgent. (2.) Indications are strong that the demand for tanker tonnage will increase. (3.) There is no indication that tanker prices will decrease. (4.) There is every incentive to pursue investigations with a view to higher commercial speed and increased efficiency, both as to scientific design and operating cost analysis, in anticipation of future construction and in the study of current performance. Tanker design for the future must continue to be forward-looking, combining vision with research, and finally, (5.) there is need for American owners and shipbuilders to get together on a balanced program of standardization of tanker types, in the interests of economy in construction. The Maritime Commission has made a splendid contribution in developing the program with respect to the fast tankers as naval auxiliaries. But this merely scratches the surface of the possibilities in co-ordinating the commercial requirements for American tankers, in establishing standard types to meet the pressing demands of tonnage replacements, refinements of design, and economy of production. The opportunities in this direction are tremendous.

Anglo-Iranian tanker at Suez—trend toward increased oil production in the Near and Middle East means a greater demand for tankers due to the longer ocean haul.

WORLD TANKER CONSTRUCTION 1938

EXCLUDING the appreciable number of vessels being converted from cargo ships to tankers, there are now 225 tankers aggregating 2,802,415 tons deadweight on order and under construction in the world. So many orders for tankers have been placed in European yards that several firms have been forced to announce that their ways would be occupied by present contracts until 1940.

Royal Dutch-Shell Group has placed the largest number of vessels, with a total of 49 tankers with 498,200 tons deadweight. Second in volume on order is Standard Oil Company of New Jersey, having 21 tankships amounting to 289,764 tons deadweight; of these 12 (187,000 tons deadweight) are in American yards and nine (102,764 tons) are placed abroad. Other American companies have placed fewer orders with domestic yards than they have with European builders, the respective amounts being 12 aggregating 179,100 tons deadweight and 22 with 306,342 tons, or altogether 34 tankers of 485,442 tons.

Country of Construction	No. of Vessels	Deadweight Capacity
Germany	42	594,300
Great Britain	45	471,230
Sweden	32	436,000
United States	24	366,100
Netherlands	24	237,800
Italy	14	158,756
Japan	13	157,300*
Denmark	12	146,725
France	6	51,804
Soviet Russia	6	46,600*
Spain	4	31,800
Belgium	3	3,800
Total	225	2,802,415

Totals for all American oil companies are 55 tankers of 775,206 tons deadweight, of which 24 (366,100 tons) are with domestic builders and 31 (409,106 tons) are abroad.

Anglo-Iranian Oil Company Ltd., British Admiralty-controlled concern, gives a good account of itself with 14 tankers, aggregating 158,450 tons deadweight.

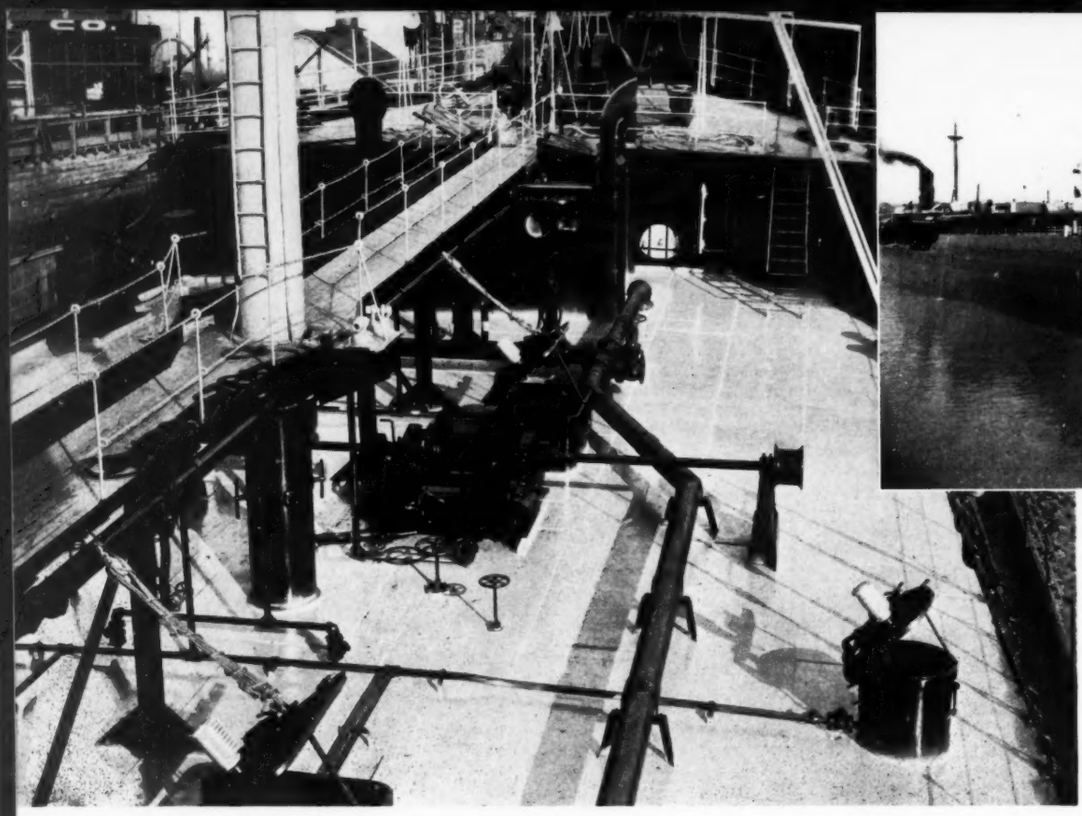
Together, the large groups (Jersey Standard, Socony-Vacuum, Royal Dutch-Shell Group, and Anglo-Iranian) account for 91 tankers aggregating 1,049,550 tons deadweight—38.81 percent of the world's contracts.

TANKERS ON ORDER AND UNDER CONSTRUCTION

(Conversions From Cargo Vessels to Tankships Not Included)

Owner	No. of Vessels	Dimensions Length/Beam/Depth	Loaded Draft	Deadweight Tonnage	Type of Engines	Total S. H. P.	R.P.M.	Loaded Sea Speed
GERMANY								
The Texas Company (Oslo)	10	494'9" x 67'0" x 34'2"	27'6"	14,000	Diesel	5,100 B	166	13½ Kt.
Standard Oil Co. of New Jersey	2	485'0" x 69'9" x 37'0"	29'9"	14,900	Diesel	3,600	110	12½ Kt.
Standard Oil Co. of New Jersey	2	483'5" x 65'9" x 35'11"	.....	14,500	Diesel	4,100 B	116	13 Kt.
Crusader Petroleum Industries	4	495'0" x 67'0" x 34'2"	27'7"	14,000	Diesel	4,100 B	115	13 Kt.
Crusader Petroleum Industries	3	470'0" x 63'10" x 35'4'	28'5"	13,900	Diesel	.....	115	....
Royal Dutch-Shell	2	460'0" x 54'6" x 30'0"	25'3"	12,100	Diesel	2,700/3,500 B	123	12 Kt.
John T. Essberger G.m.b.H.	1	483'5" x 65'9" x 35'11"	.....	14,500	Diesel	4,100 B	116	13 Kt.
Hansa Tank-Reederei	1	.....x.....x.....	.....	15,000	Diesel	4,300 B	...	13 Kt.
Frachtschiffahrt G.m.b.H.	1	.....x.....x.....	.....	15,000	Diesel	4,300 B	....	13 Kt.
Leonhardt and Blumberg	1	.....x.....x.....	.....	15,000	Diesel	4,300 B	...	13 Kt.
Lever Brothers	1	483'5" x 65'9" x 35'11"	.....	14,500	Diesel	4,100 B	116	13 Kt.
Knut Knutsen	1	500'0" x 68'6" x.....	29'0"	16,000	Diesel	4,500 B	110	13 Kt.
Jacob Kjode A/S	1	500'0" x 68'6" x 36'4½"	29'0"	16,000	Diesel	4,500 B	110	13 Kt.
Thor Dahl	1	500'0" x 68'6" x.....	.....	16,000	Diesel	4,500 B	110	13 Kt.
Compania Maritima Escandinavia Panama	1	500'0" x 68'6" x.....	.....	16,000	Diesel	4,500 B	110	13 Kt.
Thorvald Berg	1	483'5" x 65'9" x 35'11"	.....	14,500	Diesel	4,100 B	116	13 Kt.
Fearnley and Eger	1	483'6" x 65'9" x 35'6"	28'0"	14,500	Diesel	4,100 B	116	13 Kt.
Leif Hoegh	1	483"5" x 65'9" x 35'11"	.....	14,500	Diesel	4,100 B	116	13 Kt.
Sigval Bergesen	1	.....x.....x.....	.....	14,500	Diesel	4,100 B	...	13 Kt.
Deutsche Oelmuhlen-Rohstoffe	1	483'5" x 65'9" x 35'11"	.....	14,500	Diesel	4,100 B	116	13 Kt.
Socony-Vacuum Oil Co.	1	.....x.....x.....	.....	11,200	Steam	.....	...	....
Socony-Vacuum Oil Co.	1	.....x.....x.....	.....	11,200	Diesel	.....	...	....
Lorentzens Rederi	1	483'0" x 65'9" x 35'11"	.....	14,800	Diesel	4,100 B	116	....
Skibs A./S. Snefonn	1	.....x.....x.....	.....	14,600	Diesel	.....	...	....
Y.P.F. (Argentine Govt. Oilfields)	1	525'0" x 61'8" x 34'11"	25'6"	11,300	T.E. Steam	7,000 I	85	15 Kt.
GREAT BRITAIN & IRELAND								
Royal Dutch-Shell Interests	5	460'0" x 61'0" x 33'3"	27'0"	12,000	Diesel	3,600	120	12 Kt.
Royal Dutch-Shell Interests	3	460'0" x 59'0" x 34'0"	27'6"	12,000	Diesel	3,500	120	12 Kt.
Royal Dutch-Shell Interests	3	460'0" x 59'0" x 34'0"	27'6"	12,100	Diesel	3,600	123	12 Kt.
Royal Dutch-Shell Interests	3	460'0" x 59'0" x 34'0"	27'6"	12,000	Diesel	3,600	123	12 Kt.
Royal Dutch-Shell Interests	2	.....x.....x.....	.....	15,000	Diesel	.....	...	....
Royal Dutch-Shell Interests	2	335'0" x 56'0" x 14'9½"	.....	4,000	Diesel	.....	...	11 Kt.
Royal Dutch-Shell Interests	1	181'6" x 29'6" x 11'9"	11'0"	900	Diesel	.....	...	10 Kt.
Royal Dutch-Shell Interests	1	.....x.....x.....	.....	4,000	Steam	.....	...	....
Anglo-Iranian Oil Co., Ltd.	7	464'2" x 61'9" x 34'1"	27'6"	12,250	Diesel	2,850	97	11½ Kt.
Anglo-Iranian Oil Co., Ltd.	2	464'2" x 61'9" x 34'0"	27'6"	12,100	Diesel	2,850	105	12 Kt.
Anglo-Iranian Oil Co., Ltd.	2	464'2" x 61'9" x 34'0"	27'6"	12,000	Diesel	2,850	105	12 Kt.
Anglo-Iranian Oil Co., Ltd.	1	464'2" x 62'1" x 34½"	27'6"	12,300	Diesel	2,850	97	11½ Kt.
Anglo-Iranian Oil Co., Ltd.	1	464'2" x 62'9" x 34'0"	27'6"	12,150	Diesel	2,320	98	12 Kt.
Anglo-Iranian Oil Co., Ltd.	1	.....x.....x.....	.....	140	Diesel	.....	...	....
Standard Oil Co. of New Jersey	1	.....x.....x.....	.....	4,650	.....	.....	...	....
Trinidad Leaseholds Ltd.	1	.....x.....x.....	.....	8,340	Steam	.....	...	....
C. T. Bowring and Co., Ltd.	1	500'0" x 68'3" x.....	.....	15,000	Diesel	4,700 B	...	12½ Kt.
British-Continental Owners	1	.....x.....x.....	.....	13,500	Diesel	.....	...	....
Westfal-Larsen and Co. A/S	2	515'0" x 69'0" x.....	.....	14,500	Diesel	4,200 B	...	13 Kt.
Prebensen and Blackstad	1	.....x.....x.....	.....	14,500	Diesel	4,200 B	...	....
Halle and Peterson	1	488'0" x 66'6" x 35'6"	.....	15,000	Diesel	.....	...	....
Union Lighterage Co.	3	157'0" x 32'0" x 10'3"	8'6"	500	Diesel	400	330	8½ Kt.
SWEDEN								
Norwegian owners	4	465'0" x 60'9" x 34'0"	26'9"	12,600	Diesel	3,700	125	13 Kt.
Norwegian owners	2	490'0" x 65'0" x 36'0"	28'7"	15,000	Diesel	4,200	...	13 Kt.
Damps Corone (H. M. Wrangell and Co.)	1	465'0" x 60'9" x 34'0"	26'9"	12,600	Diesel	3,700	125	13 Kt.
Kristiansands Tankrederi A/S	1	465'0" x 60'9" x 34'0"	26'9"	12,600	Diesel	3,700	125	13 Kt.
Magnus Konow	1	485'0" x 65'9" x 36'9"	28'6"	15,000	Diesel	4,250	115	12½ Kt.
I. M. Skaugen	1	471'0" x 59'0" x 35'0"	27'7"	12,600	Diesel	5,000 I	...	....
Argentine Owners	1	471'0" x 59'0" x 35'0"	27'7"	12,600	Diesel	5,000 I	...	....
.....	4	471'0" x 59'0" x 35'0"	27'7"	12,600	Diesel	5,000 I	...	....
A. S. Onassis	1	.....x.....x.....	.....	15,200	Diesel	4,500 B	...	....
Johannes Hansen	1	483'6" x 59'0" x 35'6"	.....	12,500	Diesel	4,800 I	110	12½ Kt.
Rederi A/S Alse	1	483'6" x 59'0" x 35'6"	.....	12,500	Diesel	4,800 I	110	12½ Kt.
Rederi Akt. Transmark	1	.....x.....x	.....	16,500	Diesel	.....	...	14½ Kt.

Owner	No. of Vessels	Dimensions Length/Beam/Depth	Loaded Draft	Deadweight Tonnage	Type of Engines	Total S. H. P.	R.P.M.	Loaded Sea Speed
Th. Brovig	1	....x....x....	29'0"	15,300	Diesel	.....	...	14 Kt.
.....	1	....x....x....	.....	12,500	Diesel	.....	...	....
.....	1	....x....x....	.....	11,500	Diesel	.....	...	....
.....	1	....x....x....	.....	15,300	Diesel	.....	...	....
Skibs A/S Gefion	1	490'0" x 62'9" x 36'7"	28'3"	14,900	Diesel	4,500	108	13 Kt.
Dampskibs A/S Avenir	1	490'0" x 62'9" x 36'7"	28'5"	14,900	Diesel	4,500	108	13 Kt.
Stockholms Rederi Akt. Svea	1	490'0" x 62'9" x 36'7"	28'5"	15,100	Diesel	5,500	120	14 Kt.
Skibs A/S Abu	1	490'0" x 62'9" x 36'7"	28'3"	15,000	Diesel	5,500	120	14 Kt.
A/S Braconda (Ludv. Braathen)	1	500'0" x 63'0" x 38'6"	29'6"	15,500	Diesel	5,500	120	14½ Kt.
Skibs A/S Navalis	1	500'0" x 63'0" x 38'6"	29'0"	15,600	Diesel	5,500	120	14 Kt.
Skibs A/S Uglands Rederi	1	465'0" x 62'0" x 34'6"	27'1"	12,500	Diesel	4,000	116	13½ Kt.
S. H. Smith Sörensen	1	465'0" x 62'0" x 34'6"	27'1"	12,500	Diesel	4,000	116	13½ Kt.
Skibs A/S Sydhav	1	465'0" x 62'0" x 34'6"	27'1"	12,500	Diesel	4,000	116	13½ Kt.
UNITED STATES								
Standard Oil Co. of New Jersey (Navy-type)	10	525'0" x 75'0" x 39'0"	30'0"	16,300	Steam turbines	12,800	85	16½ Kt.
Standard Oil Co. of New Jersey	2	442'0" x 64'0" x 34'10"	28'4"	13,000	Steam turbines	3,500	85	13 Kt.
Sun Oil Co.	1	521'0" x 70'0" x 40'0"	30'2"	18,200	Diesel	6,000	85	14 Kt.
Atlantic Refining Company	1	521'0" x 70'0" x 40'0"	29'7¼"	18,500	Turbo-electric	5,000 B	90	13¼ Kt.
Socony-Vacuum Oil Co.	2	501'7½" x 68'0" x 37'0"	30'0"	16,250	Steam turbines	4,000	75	13 Kt.
Bernuth-Lembcke Co.	1	442'0" x 65'0" x 35'0"	28'7¾"	13,000	Steam turbines	3,500	85	13 Kt.
Union Oil Co. of California	1	442'0" x 64'0" x 34'10"	28'4"	13,000	Steam turbines	3,500	85	13 Kt.
The Texas Corp.	1	489'11½"x65'0"x34'3"	27'9"	12,600	Steam turbines	5,000	93	13½ Kt.
Pan American Pet. and Trans. Co.	2	435'0" x 66'6" x 34'6"	28'0"	12,850	Steam turbines	3,000	90	12½ Kt.
Keystone Tankship Corp. (Navy-type)	2	525'0" x 75'0" x 39'0"	30'0"	16,300	Steam turbines	12,800	85	16½ Kt.
Tide Water Associated Oil Co.	1	442'0" x 65'0" x 35'0"	28'7¾"	13,000	Steam turbines	3,500	85	13 Kt.
NETHERLANDS								
Royal Dutch-Shell Interests	10	460'0" x 59'0" x 34'0"	27'6"	12,100	Diesel	3,600	120	12 Kt.
Royal Dutch-Shell Interests	6	425'0" x 54'4" x 31'0"	25'6"	9,100	Diesel	2,800	120	12 Kt.
Royal Dutch-Shell Interests	2	500'0" x 64'3" x 37'0"	29'7"	15,300	Diesel	5,000	125	13 Kt.
Royal Dutch-Shell Interests	2	330'0" x 46'6" x 20'0"	18'6"	4,100	Diesel	1,600	145	11¼ Kt.
Royal Dutch-Shell Interests	1	325'0" x 49'6" x 15'0"	13'11"	4,000	Steam	2,500 I	175	11½ Kt.
Royal Dutch-Shell Interests	1	305'0" x 41'9" x 35'0"	.....	3,800	Diesel	1,600 B	145	11 Kt.
Stoomvaart Mij "De Maas"	1	488'0" x 73'0" x 35'5"	28'3"	15,200	Diesel	3,750	90	12¾Kt.
Brazilian Owners	1	180'0" x 25'0" x 7'0"	6'0"	400	Diesel	400	350	10 Kt.
ITALY								
Standard-Vacuum Oil Co.	2	485'0" x 69'9" x 37'0"	29'11"	15,414	Diesel	3,600	110	12½ Kt.
Standard Oil Co. of New Jersey	2	350'0" x 60'0" x 17'6"	13'5½"	4,600	T. E. Steam	1,900 I	...	10½ Kt.
Standard Oil Co. of New Jersey	1	485'0" x 69'9" x 37'0"	29'11"	15,414	Diesel	3,600	110	12½ Kt.
Royal Dutch-Shell Interests	2	425'0" x 54'3" x 31'0"	25'7"	9,150	Diesel	2,800	120	12 Kt.
Royal Dutch-Shell Interests	1	330'0" x 46'6" x 20'0"	18'6"	4,100	Diesel	1,600	145	11¼ Kt.
A.G.I.P. (Italian Govt. Oil Company)	1	490'3" x 68'4" x 36'5"	29'3"	14,500	Diesel	4,500	105	14 Kt.
A.G.I.P. (Italian Govt. Oil Company)	1	522'8" x 68'7" x 36'7"	27'8"	13,500	Diesel	7,800 I	145	14 Kt.
A.G.I.P. (Italian Govt. Oil Company)	1	505'0" x 68'0" x 36'6"	27'6"	13,500	Diesel	.....	...	14 Kt.
Socony-Vacuum Oil Co.	1	485'0" x 69'9" x 37'0"	29'11"	15,414	Diesel	3,600	110	12½ Kt.
Achille Lauro and Co.	2	.....x.....x.....	.....	12,000	Diesel	3,800 B	...	15 Kt.
JAPAN								
Imperial Navy	2	.....x.....x.....	.....	13,500	Diesel	.....	...	19 Kt.
Asam Bussan	1	.....x.....x.....	.....	12,000	Diesel	9,500 B	...	17 Kt.
Showa Kissen Kaisha	1	.....x.....x.....	.....	12,000	Diesel	9,500 B	...	17 Kt.
Kokuyo Kissen Kaisha	2	500'0" x 65'2" x	.....	13,000	Diesel	9,000 B	...	16½ Kt.
Kioto Kjoto Kissen Kaisha	1	.....x.....x.....	.....	12,000	Diesel	9,500 B	...	17 Kt.
Nippon Suisan Kissen Kaisha	1	500'0" x 65'0" x 37'1"	.....	15,000	Diesel	9,500 B	...	17 Kt.
Dairen Kissen Kaisha	1	.....x.....x.....	.....	5,500	Diesel	.....	...	13 Kt.
Also four other tankers for which no details are available, probably about 12,000 d.w. tons each.								
DENMARK								
Standard Oil Co. of New Jersey	1	.....x.....x.....	.....	14,700	Diesel	5,600 I	...	....
Cie. Auxiliaire de Navigation	1	.....x.....x.....	.....	15,500	Diesel	.....	...	....
Royal Dutch-Shell Interests	2	425'0" x 54'6" x 30'0"	25'3"	9,100	Diesel	2,700 B	123	12 Kt.
Hunting and Sons	2	470'0" x 61'6" x	27'6"	12,500	Diesel	5,680 I	...	13½ Kt.
Phs. Van Ommeren	1	480'0" x 65'3" x	.....	14,500	Diesel	4,700 I	...	12 Kt.
H. E. Moss and Co.	1	.....x.....x.....	.....	14,500	Diesel	4,700 I	...	12 Kt.
A. P. Moller	1	501'0" x 65'3" x 35'10"	.....	14,500	Diesel	4,700 I	...	12 Kt.
Anglo-Danish Petroleum Co.	1	.....x.....x.....	.....	14,500	Diesel	.....	...	....
Stockholms Rederi Akt. Svea	1	485'0" x 65'9" x 36'6"	29'1"	15,000	Diesel	5,500	108	14 Kt.
Det. Dansk Petroleums A/S	1	.....x.....x.....	.....	325	Diesel	.....	....	.....
FRANCE								
French Navy	1	.....x.....x.....	.....	4,510	Turbines	.....	...	....
French Navy	1	.....x.....x.....	.....	1,950	Steam	.....	...	....
French Navy	2	408'0" x 53'0" x 30'6"	20'8"	7,443	Steam Turbines	5,200	120	15 + Kt.
Cie. Auxiliaire de Navigation	1	545'2" x 71'6" x 39'5"	30'8"	27,552	Diesel	7,200	120	14 Kt.
Soc. Fluviale and Maritime	1	232'10" x 35'8" x 16'8"	15'7"	2,906	Compound 2 cyl. B.P Brouer System	950 I	140	10½ Kt.
U. S. S. R.								
Sovtorgflot—Export Fleet	1	420'0" x 54'2" x	.....	7,900	Diesel	.....	...	....
Sovtorgflot—Export Fleet	1	.....x.....x.....	.....	8,300	Diesel	.....	...	....
Sovtorgflot—Caspian Sea Fleet	4	.....x.....x.....	.....	.....	Diesel	.....	...	....
SPAIN								
C.A.M.P.S.A. (Spanish Oil Monopoly)	2	461'0" x 62'0" x	27'0"	10,900	Diesel	3,600B	...	12¾Kt.
C.A.M.P.S.A. (Spanish Oil Monopoly)	2	.....x.....x.....	.....	5,000	Diesel	.....	...	....
BELGIUM								
Swiss Owners	1	.....x.....x.....	.....	1,800	Diesel	.....	...	....
French Owners	1	.....x.....x.....	....	1,000	Diesel	.....	...	....
Norwegian Owners	1	.....x.....x.....	.....	1,000	Diesel	.....	...	....
WORLD TOTAL	225			2,802,415				



Above: Modern 6,000 ton deadweight tanker Amsco, 385 ft. 9 in. overall with 16 main cargo tanks and eight summer tanks giving a capacity of 60,000 bbl. Construction is all-welded and she is powered with 2,000 i.h.p. triple-expansion reciprocating steam engines. The Amsco was converted from a double-bottomed hull constructed during the war for dry cargo service. Twenty years of idleness failed to produce any serious deterioration as revealed during conversion by Ingalls Ironworks Co. Left: View forward from bridge showing new oil hatches, catwalk and piping installation on deck.

TANKER VALUE Per Unit of Expenditure

Comment of an Authority with Many Years' Experience in Construction and Operation Representing American Shipbuilders' Attitude.

PERIODICALLY the American shipbuilder comes into national prominence when steps are taken to rehabilitate the United States Merchant Marine. The immediate question of price differences between domestic and European ships is naturally considered in a nationalistic light. The consideration of allotting large sums of money for American naval building and the Maritime Commission's studies and activities in behalf of the Merchant Marine, have again created widespread discussion of the position that the shipbuilder holds towards his patron, the American shipowner.

The following remarks are not concerned with subsidized fast naval auxiliaries, but with the economically-paced 12 to 13 knot tanker. Current international economic conditions, especially the recent design developments of oil carriers in the United States, have changed the competitive aspect of the American shipbuilder in this field.

A review of European shipbuilding conditions shows that a sharp rise in shipbuilding prices occurred in the first quarter of 1937. Prices continued upward to a peak in December, a point only exceeded by wartime costs. Although orders have fallen off in 1938, no parallel decline in European prices is evident.

British shipbuilders have repeatedly claimed that from 60 to 70 percent of construction costs are not within their control, and acknowledge that their suppliers have approximately that percentage of influence on their costs. In May, 1937, British steel prices showed a general increase of 20 percent and although an anticipated price rise for the first quarter of 1938 did not materialize, no reduction is expected for the remainder of the year.

It is generally considered that no great reduction in overseas tankship prices can be expected in the near future, particularly with increased naval shipbuilding. Deliveries of tankers have been slower abroad than in the United States.

The European price per ton at the current rate of exchange has recently been of the order of $85.00 to $100.00 for 12 knot vessels of from 10,000 to 15,000 deadweight tons. Prices have been recorded for sales of ships built four to five years ago around $81.00 per ton. American prices for new construction are of the order of $130.00 to $145.00 per ton. The differential does not represent direct savings to the buyer.

The American builder's ability to produce a creditable product is unquestioned. His designs and workmanship have created ships of unsurpassed economy. Higher carrying capacities due to reduced hull and machinery weights together with improved hull forms have resulted in reduced power requirements, and the efficiency of American propelling units has been enormously increased. The costs of these improvements are necessarily reflected in the vessels' prices and much of the added amounts have proven recoverable through operation.

The demands of shipowners on the American shipbuilder for surplus capacities in operating equipment and additional safety facilities have provided overseas competition with a distinct initial price advantage. This applies to the deck machinery, pumping plant, refrigeration, navigation equipment as well as engine room auxiliaries.

Living quarters with a higher degree of safety and comfort are, of necessity, more elaborate to conform to the higher standards required by the American way of living. This accounts for considerable additional expense. Provisions are made for larger crews and roomier quarters with commodious plumbing, lighting and furnishings. The extent to which the above added requirements increase the cost of a ship is seldom given sufficient weight in discussing this subject.

American nationalism with all its aspects of employment, defense and the development of home markets, has become a less potent factor in the sale of moderate speed tankers.

In spite of relatively high labor costs, the quickly-delivered American tanker gives a value per dollar expended in excess of that obtained in the European tankship. Herein lies the American shipbuilder's claim to competition.

British CONSTRUCTION

By A. C. Hardy
B.Sc., A.M.I.N.A., F.R.G.S.

SHIPBUILDERS are still grateful for tanker orders in spite of activity in most European yards with warship construction, and—until relatively recently—a spate of replacement orders for new passenger, cargo liner and coaster orders. In Great Britain the dearth of new contracts, due on the one hand to what the owner considers excessive price and on the other to what the builder feels is just reward for labor with but little margin of profit, is causing some anxiety. This will tend to make the oil companies even more welcome customers. Experience has shown that the major groups have ever been the shipbuilders' best friend.

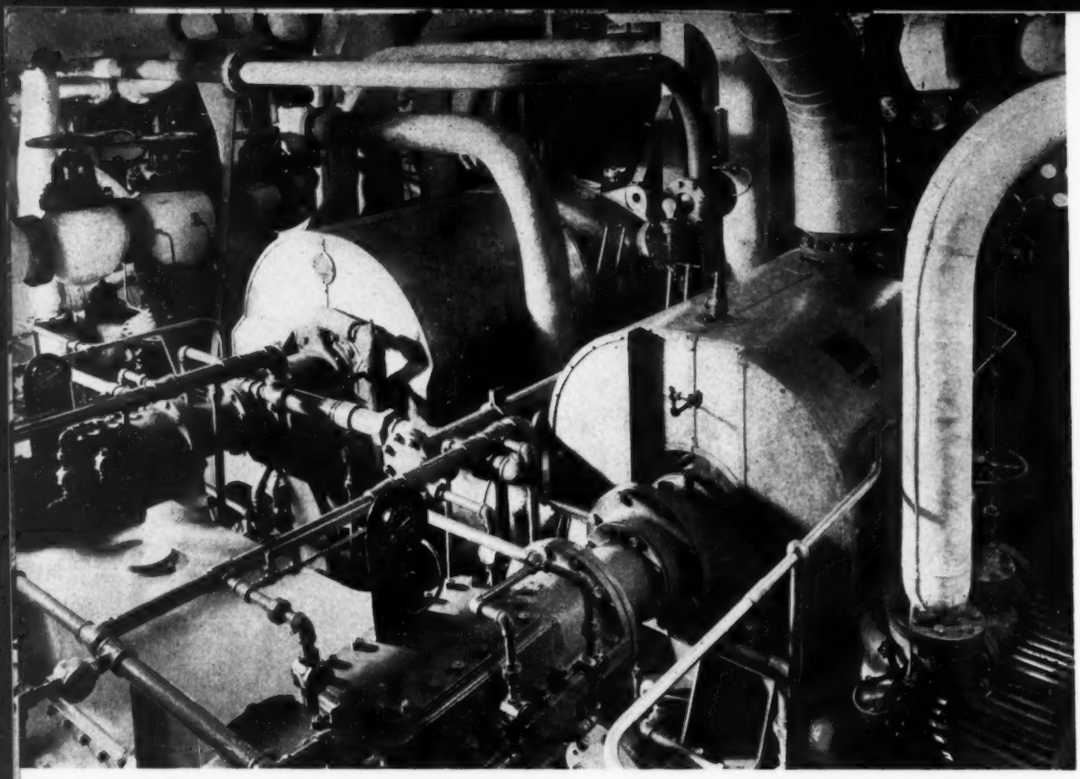
In general the shipbuilder realizes this. He is appreciative too, of the fact that oil tanker fleets more than any others are in constant need of modernization and replacement; he is aware that the researches in ship structure and ship propulsion which he was able to carry out in the lean years now place him in an enviable position of being able to offer units of such efficiency that in all but times of the highest and sometimes most unnatural freight rates, the older ships become uneconomical to run. This situation is a piquant one at the present moment when the earliest of some 50 to 60 Diesel ships still on 10 year charters are due to return to the open market during 1938, but in some cases further employment has already been arranged.

Judged by modern standards these ships are obsolete. Their obsolescence is due not to their fuel consumption but to the fact that, for the power generated on twin screws, the space taken up is excessive compared with what would be required to-day. Because of their indifferent hull forms, the daily fuel oil consumption is excessive compared with what would be necessary at the present time. Many of the earlier charter tankers have four-cycle single-acting air injection engines coupled to each of two screws. This particular style of Diesel propulsion is now antedated and the injection air compressor is a machine which the practical marine engineer has long wished consigned to the limbo of the past. The modern tanker can develop upwards of 3,000 h.p. on a single screw in as economical a space as the tanker of ten years ago could on twin screws. A double-acting two-cycle engine is capable of giving 3,000 h.p. in six cylinders just as a single-acting four-cycle continuously supercharged engine can in eight cylinders. Consequently there is a tendency for the twin screw tanker, for all except the highest powers, to be superseded by a single screw unit.

Courtesy of Foster-Wheeler, Inc.

Much has been made in European circles of the success of American geared-turbine tankers such as the Gulfwave.

Factors such as these have only to be mentioned to indicate the broad choice of propulsion equipment that still exists for the modern tanker owner. Selection is ultimately determined by the service speed that is demanded. This in turn is affected by two points: (1) the type of service engaged on, and (2) the financial relationship between the owner of the tankship and the nation under whose flag the vessel operates. Companies under the maritime control of nations whose shipping is in the main self-supporting are apt to feel that service speed of 12½ knots for a 10,000 to 12,000 ton capacity tanker in fully loaded condition is sufficient. The only real reason for this point of view is that the speed chosen comes within the realms of economic transportation. From a purely dividend earning point of view, this idea is undoubtedly correct. On the other hand, the faster the speed of the individual unit the smaller the number of units required to carry a given quantity of cargo between two points. Nowhere has this been more practically demonstrated than on the route between San Pedro, California, and Yokohama. Japanese owners were the first to develop the idea that a tanker could travel economically at more than 11 knots. They have been accused of entirely militaristic reasons for their interest in higher speeds. This is not exactly correct, because in moving supplies of oil from California to Nippon the transportation companies were faced with the problem of taking continuous supplies to maintain Japanese levels to a high pre-determined level. That this figure may have been determined by military reasons cannot be gainsaid. In a country whose mercantile marine is smiled upon by Government support, cost of speed is not a primary consideration. Consequently Japan has set a new high level in tanker speeds, having constructed ships with upward of 8,000 h.p.



Turbines and gears from the starboard side of the Wallace E. Pratt—in Great Britain such propulsion equipment is regarded with interest and respect.

on a single screw with a low fuel consumption. That which has been done under the Japanese flag for special reasons should not be ignored by other countries whose tanker operating conditions may be different.

General opinion in England is that in recent orders placed for tank ships under the British flag, in particular those which are likely to carry Navy oil, current mercantile practice of non-subsidised nations has been followed too closely. There appears to be no logical reason why ships carrying oil from the Gulf of Iran to British Naval bases should not have a mean service speed of 18-20 knots; indeed if they are Navy tankers, it is surprising that any reasoning to the contrary should prevail.

Companies such as Standard of New Jersey, Standard of California and their respective subsidiaries, or the Royal Dutch-Shell group, who are the mainstays of commercial oil supply throughout the world and whose connections are essentially international, have perhaps a different problem to solve, and are feeling their way toward higher speed gradually. International shipbuilding is grateful for the benefits the respective groups shower upon it and opinion connected therewith would not necessarily welcome the evolution of a fleet which, by reason of its high speed, would tend to cut down the number of building orders placed.

With ships intended in whole or in part for Navy purposes the question is entirely different. Let us establish the fact that for ordinary commercial work, where a reasonable investment return must be gained, 12½ knots with 3,600 s.h.p. is estimable.

If higher speeds are sought and, as might naturally be expected, government assistance accompanies them, then other and special considerations enter into the type of power plant to be used. It is the easiest thing to design a tanker of 12,000 tons capacity which can operate at 18 knots speed with machinery in a compact space.

When such kinds of machinery are considered, the question arises as to what will be the first cost of the machinery. Setting this aside for the moment and admitting that the highest powered and fastest tankers are a matter for special consideration, what is the choice of machinery? Geared turbines with watertube boilers can be used; or Diesel engines. The former is not confined to special fast tankers for already American owners have written a noteworthy page in the history of marine engineering progress by the work they have done in fitting double-reduction geared-turbine sets to a single screw, these latter taking their power from watertube boilers. The arrangement is that the watertube boilers are abaft and above the shaft of the main turbine. Specific consumptions upwards of 0.65 lb. per s.h.p. hour have been obtained.

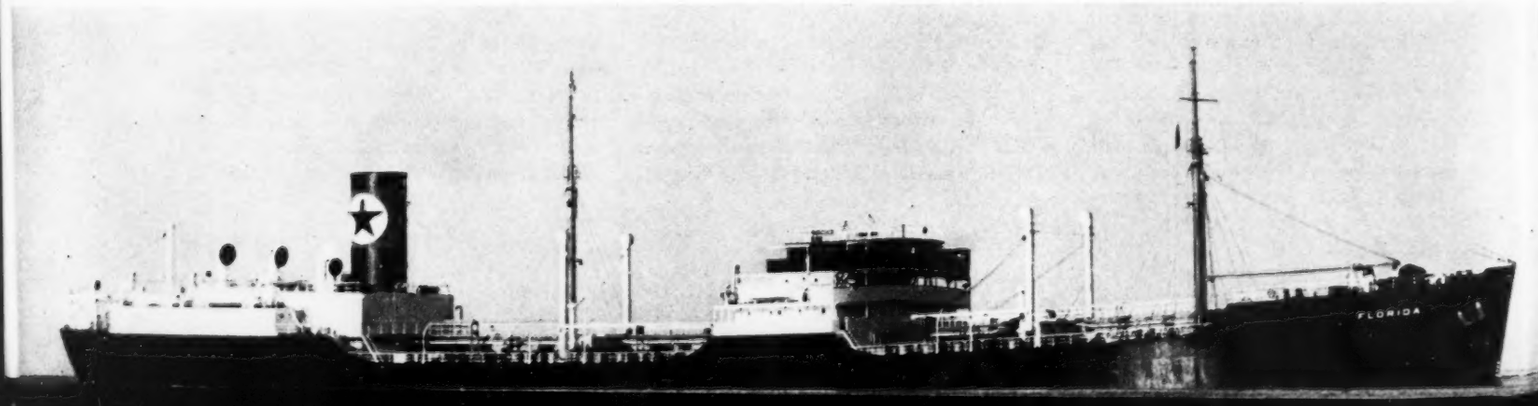
As far as one is able to judge from discussions with competent tanker authorities in Great Britain, such propulsion equipment is regarded with a great deal of interest and no little respect. At the same time its success compared with that of a Diesel plant of equal output depends upon the price of Diesel oil as compared with boiler oil. The feeling of most tanker owning companies is that for long hauls on world trade routes, the steam job falls down when compared with the Diesel installation, if only because of its lower specific fuel consumption, i.e. 0.36 lb. per s.h.p. hour, compared with that of the steam job. Space for space and weight for weight, there is little to compare.

As regards auxiliary power the fact that the turbine set is able to drive a generator from an extension of one of the pinions means that the daily consumption for all purposes is roughly equivalent to the fuel demand for the main and auxiliary machinery. This is an advantage countered in the modern Diesel plant by the fact that exhaust steam can be generated in boilers to drive a 12½ kw. set for lighting and steering purposes while the ship is at sea.

Modern seagoing plant, in fact, drives all its own pump equipment and auxiliary machinery, and is completely self-contained. The same can be said of the geared-turbine set—but at a slightly higher specific fuel consumption. Therefore, choice of one or the other is a matter of relative price of boiler and Diesel oil on the trade routes.

It would seem, as far as one can gather from discussion with competent authorities, unlikely that any great change of views on propulsion problems will take place in tanker owning circles. The marine Diesel is still increasing in efficiency as regards upkeep cost. Its first cost to the shipowner is becoming less while its compactness is a matter to be reckoned with as each succes-

The Texas Corporation is one of the few owners of American-built Diesel tankers—a recent addition, the Florida.

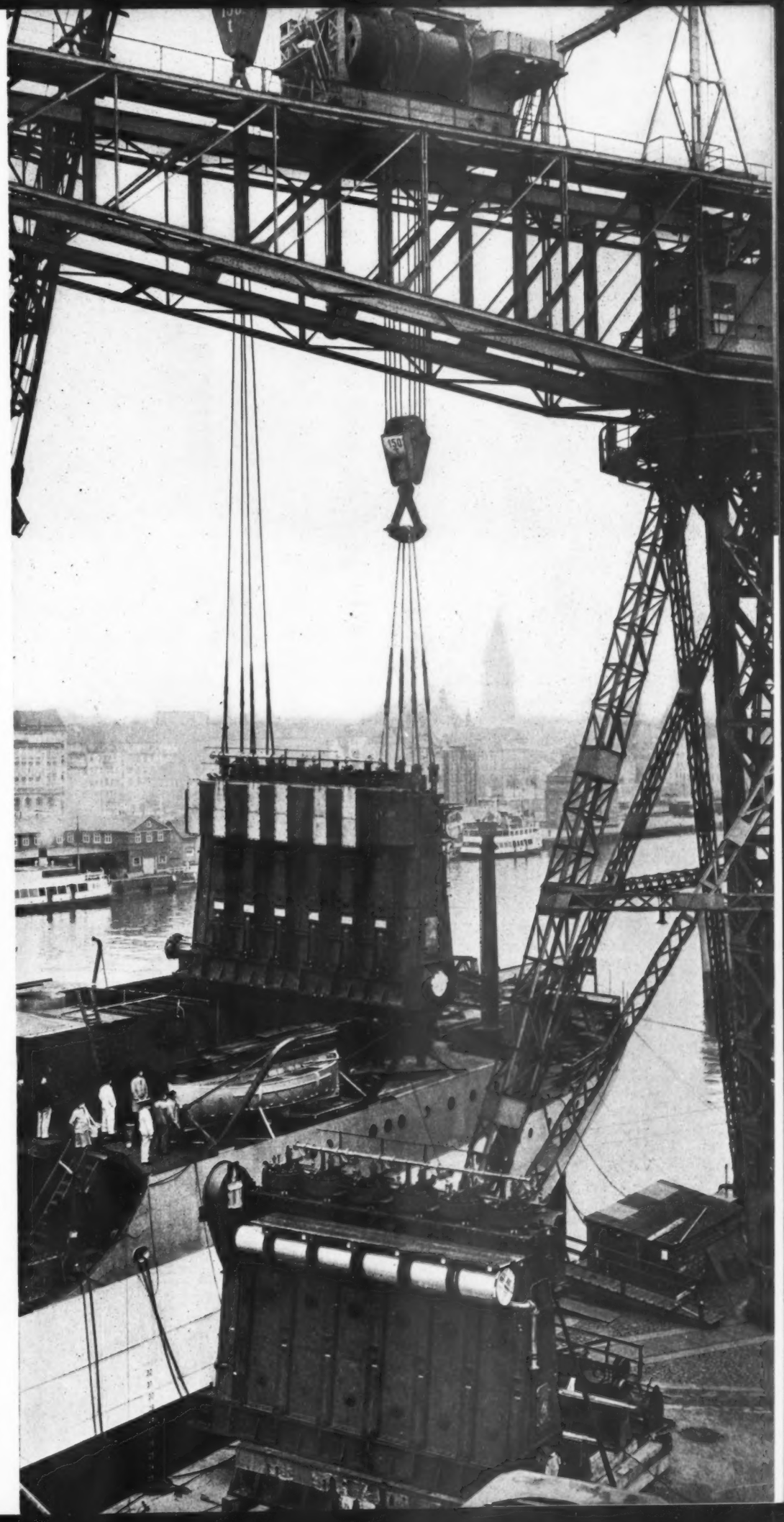


sive design is brought out. The use of welding has reduced specific weight. All these advantages, however, must be increased and consolidated if the Diesel engine is to maintain the hold which it has on marine propulsion in Europe and Japan, and if it is to make headway in America.

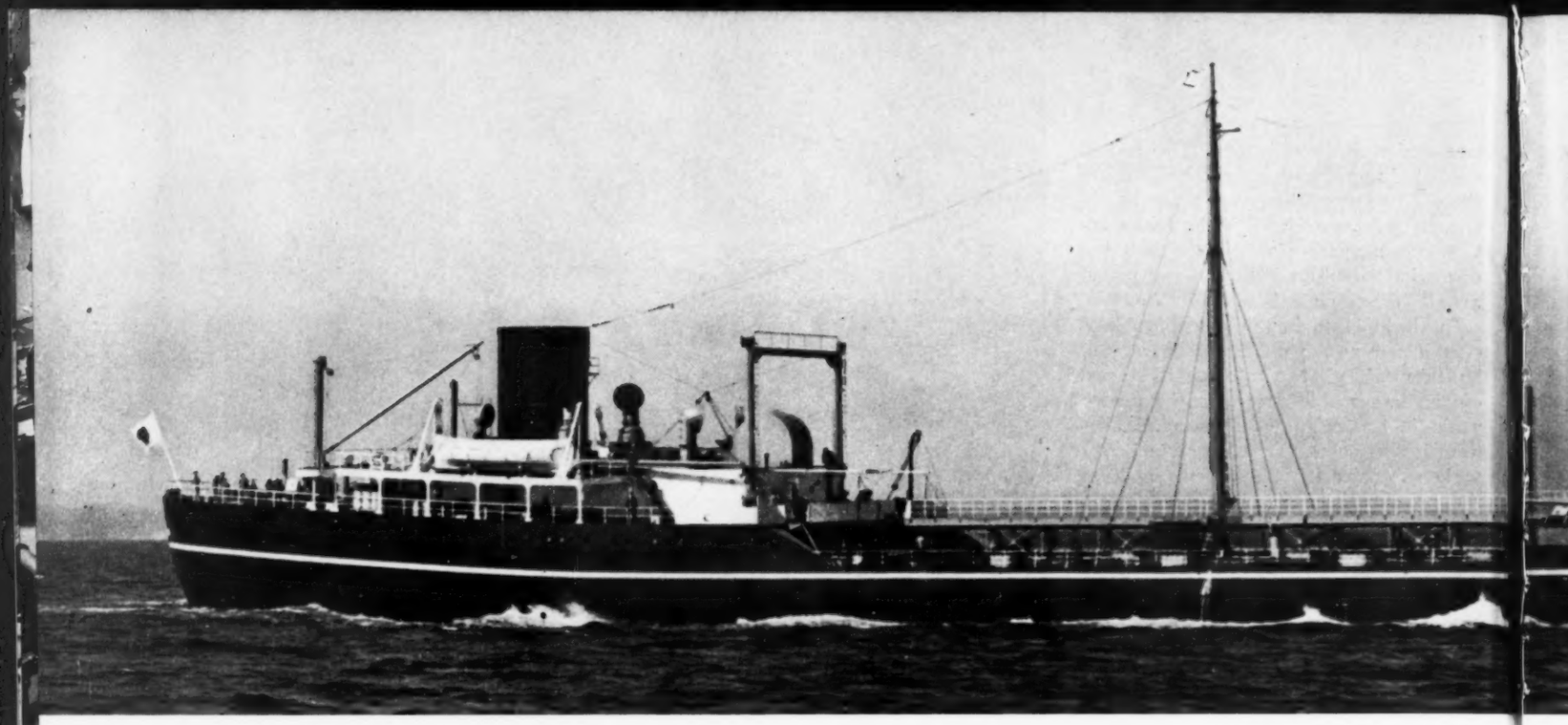
On the hull side the shipbuilder is able to offer increasing advantages in the way of hull forms. The late Sir Joseph Isherwood did an inestimable service to the marine world in producing the Arcform. Maierform is also popular in a large number of tankers, particularly those being built at the present time for long term charter work. In this connection it is interesting to note that one Maierform ship recently completed, the KONGSGAARD, left Aruba at the same time as another tanker of the same size, but with normal form, left Curacao. The islands are about 50 mi. apart. Both ships had shown excellent results on their trial trips, namely 14½ knots, but the Maierform vessel arrived at Antwerp 2½ days earlier than the normal form ship. This point is made not in any spirit of glorification of one style of hull form, but to indicate that special hull forms have much to recommend them. With these special hull forms have come the development of streamlined superstructures and new thought on the arrangement of accommodations for officers and men.

This latter is particularly important at the moment in view of the new British and American regulations. Proper execution of the B.O.T. Regulations is resulting in the placing of a good deal of work with repair yards in Great Britain for bringing all accommodations in line with modern requirements.

Contemporary with all these developments have come improvements in navigational devices. The modern tanker today is not well equipped unless she has a radio direction finder, an echo sounder and an automatic gyro steering gear. All of which points tend to put up the first cost. As regards this latter, while it should be emphasized that the shipbuilder in no sense of the word looks upon the tanker owner as a potential commercial victim, it is generally realized in authoritative shipbuilding circles that the tanker offers a much more intelligent interpretation of what is possible in modern ship construction than many ordinary cargo carriers. In any event, it is likely that tankship construction will continue to be one of the most valuable outlets for the shipbuilding industry.



The marine Diesel is increasing in efficiency and is the prevalent form of motive power in international tanker service—installing two 2,400 b.h.p. Diesels in California Standard's German-built ship, China.



U. S. Tankers as Naval Auxiliaries

CO-ORDINATION of the general maritime policy of the United States with the needs of the Navy and the operating requirements of oil companies was the outstanding development of the past year in the American tanker field. It was signalized by the announcement, in December last, that Standard Oil Company (New Jersey) had agreed to undertake the building of twelve 16½ knot service-speed vessels incorporating features that would make them available for naval use, the government to pay the additional expense involved. The same terms were offered to other oil companies and it is the expectation of the Maritime Commission that contracts for additional tankers will be closed within a short time. Two of the vessels building under the contract with Jersey Standard have been allocated by agreement to Keystone Tankship Company of Philadelphia.

For a number of years officials of the Navy Department have been waiting anxiously for determination of a definite maritime policy by the United States to improve the Navy's position in the matter of auxiliary oilers, which was a cause of growing concern with the increasing obsolescense of its own tanker equipment. During 1937 the Department proposed to convert five of its steam driven tankers to geared Diesel drive, but apparently was unable to obtain the necessary appropriation. Congress, however, did authorize the construction of a new naval tanker of about 12,000 tons deadweight, although no actual appropriation was made last year. It is now probable that the government will take over one of the 16,300 deadweight ton vessels ordered by Jersey Standard, inasmuch as the cost will be less than that of an individual vessel designed to naval standards.

Of consequence in surveying the present status of the U.S. Navy Department's tanker fleet are the general details outlining the obsolescence of the vessels and their efficiency, or lack of efficiency as the case may be, for operation in connection with fleet activities. These statistics are favorably affected by the withdrawal in recent years of the least serviceable vessels, but up to now these have not been replaced. According to the last available list the fleet consists of but 18 oilers aggregating 192,766 deadweight tons, or an average size of 10,709 tons deadweight. Individual sizes range from 3,766 tons to 12,600 tons and they are readily divisible into three distinct classes of vessels. The most modern and up-to-date fleet tender is 17 years old, others increasing in age up to 23 years. They vary in speed from 8.5 knots to 14 knots maximum, with an average of 11.6 knots, and in the entire fleet there are only a half-dozen moderately fast ships—which total 57,600 tons deadweight—attaining service speeds of 14 knots as compared with naval tankers of other nations having service speeds of 15, 16, and 19 knots.

Considering these factors it will be readily seen in what a critical position the U.S. Navy is. With contracts already placed for a dozen fast geared-turbine tankers, the Department can breathe a little more easily, although its requirements are by no means satisfied.

United States Naval Tanker Fleet

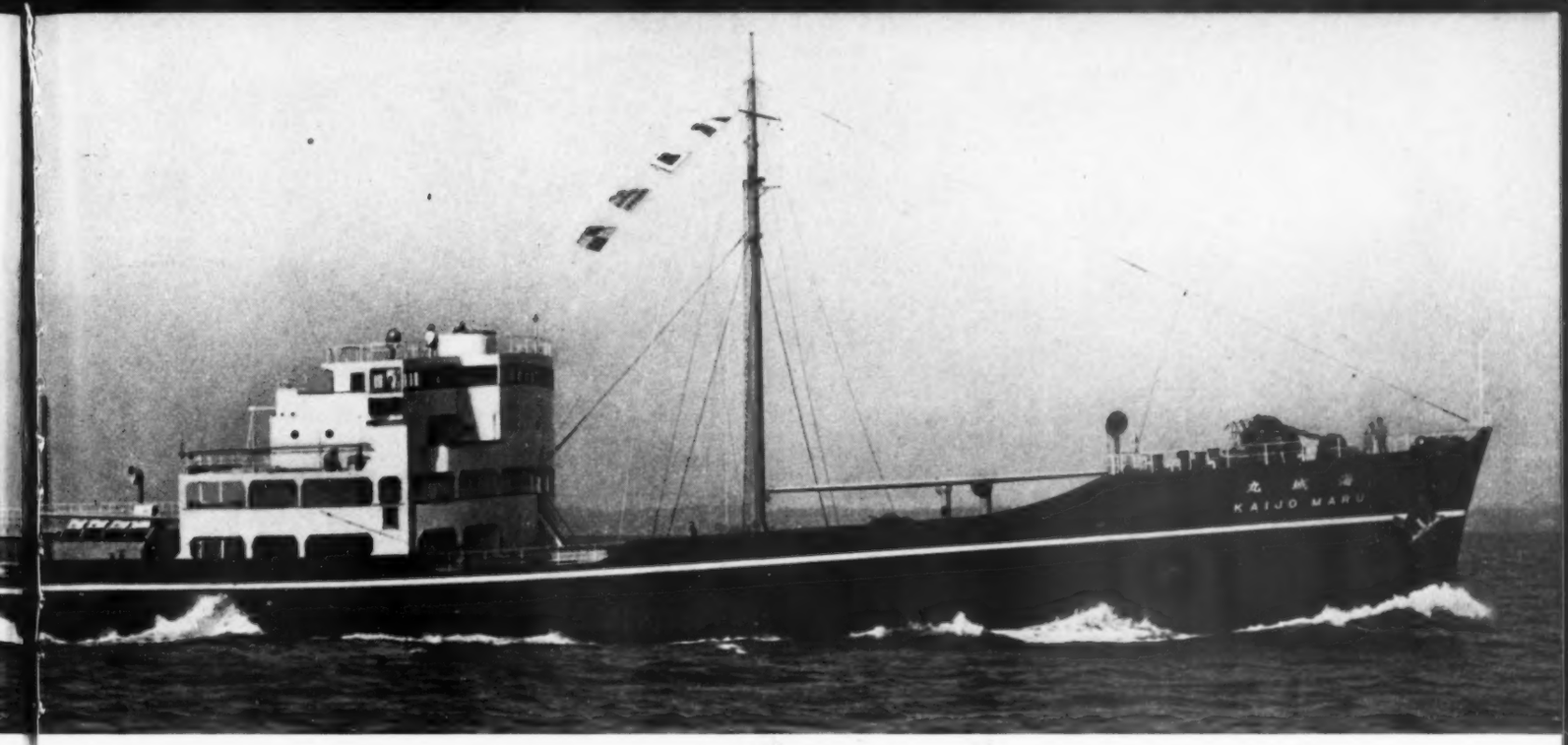
Oiler	Deadweight (Tons)	Speed (Knots)	Age (Years)
Brazos	9,500	14.0	19
Cuyama	9,700	14.0	21
Kanawha	9,800	14.0	23
Kaweah	10,200	11.0	19
Laramie	10,200	11.0	18
Mattole	10,200	11.0	18
Maumee	9,800	14.0	22
Neches	9,400	14.0	18
Patoka	12,600	10.5	19
Pecos	9,400	14.0	17
Ramapo	12,600	10.5	19
Rapidan	12,600	10.5	19
Robert L. Barnes	3,766	8.5	21
Salinas	12,600	10.5	18
Sapelo	12,600	10.5	18
Sepulga	12,600	10.5	18
Tippecanoe	12,600	10.5	18
Trinity	12,600	10.5	18

The report of the Maritime Commission stated that immediate requirements included the construction of 20 tankers, and that 40 would be necessary during the next five years. Definite negotiations are under way with several other oil companies for slightly smaller vessels—12,000 to 14,000 tons deadweight—some Diesel propelled.

Originally, the Commission solicited 28 companies with regard to construction of these vessels.

Most likely to take immediate action by way of early high-speed tanker construction would appear to be Sun Oil Company, The Texas Corporation, and Socony-Vacuum. The first two have a distinct preference for Diesel propulsion.

The Navy Department will let the oil companies build additional vessels in accordance with their own time requirements. The immediate urgency has been met, and the Department is not setting any definite schedule of vessels per year. As the figure of 40 vessels set by the Commission was a minimum, the number to be built will be limited only by the appropriation available



With a service speed of about 15½ knots, the Japanese Kaijo Maru is said to have been designed for maximum economy of operation rather than for fast voyages.

JAPAN'S Tanker Output Restricted in 1937

By Morio D. Otaki

ONLY SIX tankers, aggregating 35,065 gross tons, were built in Japan for domestic requirements during 1937—although the actual shipyard output that year totalled 10 tankships of 43,042 gross tons. Of these, three vessels aggregating 12,704 gross tons were constructed in the first half of the year, and seven totalling 30,968 gross tons were built in the final six months.

The beginning of 1938 saw on order, construction of which had yet to be commenced, 11 tankers of 63,800 gross tons.

Four small tankers of the 1937 construction program in Japan were destined for Russia. In accordance with the agreement pertaining to the Chinese Eastern Railway. The four tankers were built at the Mitsubishi Yokohama yard, and named: T. No. 9, T. No. 21, No. 3 and No. 4 (apparently yard numbers); they were delivered to the Soviet Trade Representative in Japan.

The most important tanker of the year to enter the petroleum trade, from the standpoint of size, was the MIMUROSAN MARU, latest addition to the oil-carrying fleet of Mitsui Bussan Kaisha.

KAIJO MARU, built by the Yokohama yard of Mitsubishi for Japan Tanker Company to serve as the flagship of the firm's tanker fleet, is registered at 8,637 gross tons and is considered the finest vessel built that year. She is equipped with most up-to-date facilities and has a loaded speed of about 15½ knots.

Japanese Tanker Construction 1937

Vessel	Gr. Tons	Owner	Builder
Mimurosan Maru	9,204	Mitsui Bussan Kaisha	Mitsuitama
Atsutasan Maru	8,660	Mitsui Bussan Kaisha	Mitsuitama
Kaijo Maru	8,637	Japan Tanker Company	Mitsubishi-Yok.
San Cremente Maru	7,735	Mitsubishi Shoji Kaisha	Mitsubishi-Nag.
Ukagisel	1,435	Mitsubishi Shoji Kaisha	Mitsubishi-Yok.
Nenetsuku	1,435	Mitsubishi Shoji Kaisha	Mitsubishi-Yok.
T. No. 9	1,435	Soviet Trade Rep.	Mitsubishi-Yok.
T. No. 20	1,423	Soviet Trade Rep.	Mitsubishi-Yok.
No. 3	1,079	Soviet Trade Rep.	Mitsubishi-Yok.
No. 4	1,040	Soviet Trade Rep.	Mitsubishi-Yok.

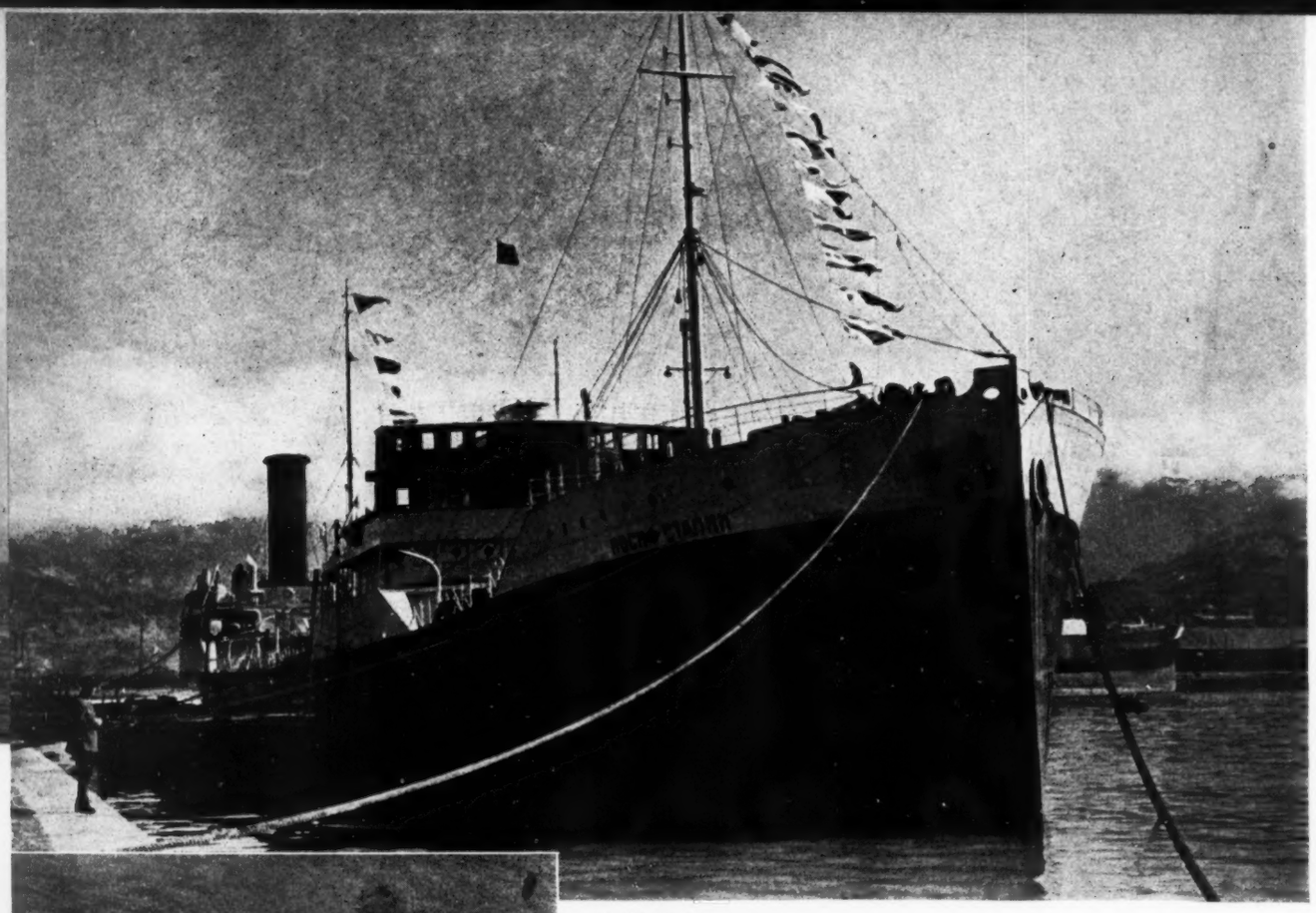
Other large tankers completed during 1937 were: ATSUTASAN MARU, 8,660 gross tons; delivered December 20th; and SAN CREMENTE MARU, 7,335 tons gross, delivered November 20th, speed of 15½ knots.

[Restrictions imposed, due to the China Incident, upon release of information so closely associated with national welfare make it difficult to obtain information regarding Japanese tanker construction. Thus we find that Mr. Otaki makes no mention of a few vessels reported through other channels. The most important of these is the 21,800 gross ton whaling base ship, largest oil tanker of the year, NISHIN MARU No. 2 (see page 68)—understood to have a deck suitable for aircraft landing.

On page 53 of this issue, two further motor tankers are mentioned as having been delivered to the Soviet Government—probably the two 1,435 ton tankships described in the accompanying table as having been constructed by Mitsubishi interests, on their own behalf.

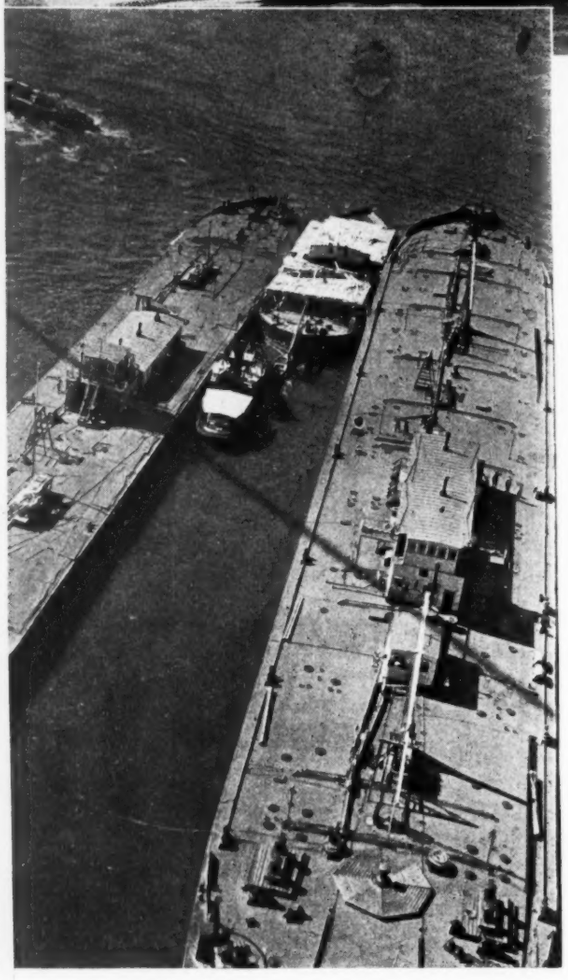
Two other vessels were nearing completion at the end of the year. ITSUKUSHIMA MARU was completing for Nippon Suisan Kissen Kaisha at Kawasaki dockyard. She is a motorship of 10,000 tons gross, propelled by a 9,500 b.h.p. two stroke double acting M.A.N.-type Diesel engine developing 9,500 b.h.p. at 125 r.p.m. Her dimensions are: length, 500 ft.; beam, 65 ft.; and depth, 37 ft. 1 in. The other tanker reported completing is that of Dairen Kissen Kaisha, at Harima dockyard. She is 4,000 tons gross and will have a service speed of 13 knots.—ED.]

One of the tankers built by Japan for the Soviet Union.



Tanker Joseph Stalin, one of the latest additions to Russia's Black Sea fleet, in the port of Batoum.

© Soviet Photo Agency



Most of Russia's production is consumed domestically and is transported up the Volga.

RUSSIAN Construction Slow

By J. Wegrin

PRIOR to the Russian revolution, Caspian Sea tanker fleets were remarkably efficient and were leaders in design and construction. Marine oil men who followed world ship construction at that time will remember that Nobels were responsible for many radical developments in hull design and pioneered in use of direct-drive Diesel and Diesel-electric propulsion machinery, setting standards which are still regarded as sound practice.

Nothing like the same proportionate progress has been made since the nationalization of the Soviet petroleum industry—additions to the tanker fleet have been slow in view of the great increase in oil output. Additions include seven small Japanese-built vessels and only two larger ships of domestic construction. The latter are the AZERBAIJAN*, 420 ft. in length, 54 ft. 2 in. in beam, with a deadweight capacity of 7,900 tons, and the SERGO ORDZONIKIDZE, of 8,300 tons deadweight; both are completing at Nikolayev. Four tankers are building at Sormovo for Caspian Sea service—believed to be of about 7,600 tons deadweight each.

*Reports do not make it clear whether this is a new vessel or merely salvage of the tanker AZERBAIJAN (built in 1934) which exploded and sank during 1936.

Major Soviet Tankers

Vessel	Built	D. W. Tons
Caspian Sea Fleet:		
Chaumian	1886	2,589
Grozni	1916	6,225
Yalta	1916	800
Alexander Emshanov	1922	1,940
Apsheron	1924	5,420
Melkop	1929	2,390
Lokbatan	1930	2,390
Skvortzov Stepanov	1931	4,000
Andrei Shdanov	1934	7,600
Stalin	1934	7,600
VKP (b)	1935	7,600
V. Molotov	1935	7,600
Soviet Georgia	1935	7,600
Peredovik	1936	2,500
Overseas Fleet:		
Surakhan Neft	1914	7,900
Sovietskaya Neft	1929	11,090
Russoilprod	1930	1,000
Stanislav Kossior	1930	9,500
Batum	1931	8,150
Sergo	1931	11,460
Moskva	1931	9,800
Varlam Aganessov	1932	9,850
Emba	——	12,000
Nikolai Jansen	1932	11,460
Soyus Vodnikov	1933	10,800
Donbas	1934	10,100
Sakhalin	1935	10,000
Ural	1935	10,000
Joseph Stalin	1936	10,900
	1937	1,000
T. No. 9	1937	1,800
T No. 21	1937	2,200
No. 3	1937	2,000
No. 4	1937	2,000
Yakagir	1937	1,845
Nenets	1937	1,845
Sergo Ordzonikidze	1938	8,300
Azerbaijan	1938	7,900

Acquisition of tankers from Japan was a part of the sale by the Soviet of the Chinese Eastern Railway, in accordance with the terms which provided for the supply by the government of Manchukuo of numerous

(Continued on page 82)

JERSEY STANDARD Fleet Additions

OUTCOME of the six months' operation of the Esso BAYONNE—first of ten additions to Standard Oil Company of New Jersey's American coastwise tanker fleet—is of primary importance not only in regard to the economics of its nine sisterships, but also because it will have a direct influence on the design and type of vessel which will figure in the future orders anticipated.

Builders' trials of merchant ships are as a rule less severe than was the sea trial of the Esso BAYONNE, but in this instance the outcome of the trial was of considerable moment. Prime requisites, already plotted through analysis of the factors involved, were to be checked by performance at sea to a greater extent than usual.

Would figures and facts agree? Observations of Felix Riesenberg, made on behalf of the NAUTICAL GAZETTE show:

SPEED TRIAL DATA

At 3:30 p.m., September 30th, 1937, at full speed.
Shaft 101.7 r.p.m.
Shaft steam pressure—boiler room gauge—420 lb.
Steam temperature at superheater outlet—780 deg.
At turbine h.p.—776 deg.
Stack temperature—300 deg. starboard uptake, 287 deg. port uptake.
Starboard fan—4 in. water col. Port fan—4 in.
Port manifold (at the burners)—1.7 in. vacuum
Starboard manifold (at the burners)—1.7 in. vacuum.
Temperature of fuel oil to burners—170 deg.
Top trial speed—14.1 knots.

Averages:	R.P.M.	SPEED	S.H.P.
	94	12.85	3,000
	97	13.19	3,300
	102	13.81	4,000

Time from full speed ahead to full speed astern—4 min. 16½ sec.

The four built at Federal S. B. Co. have Isherwood Arcform. The ten represent an investment of $16,000,000, quite apart from the subsequent orders for the more-expensive naval-type vessels.

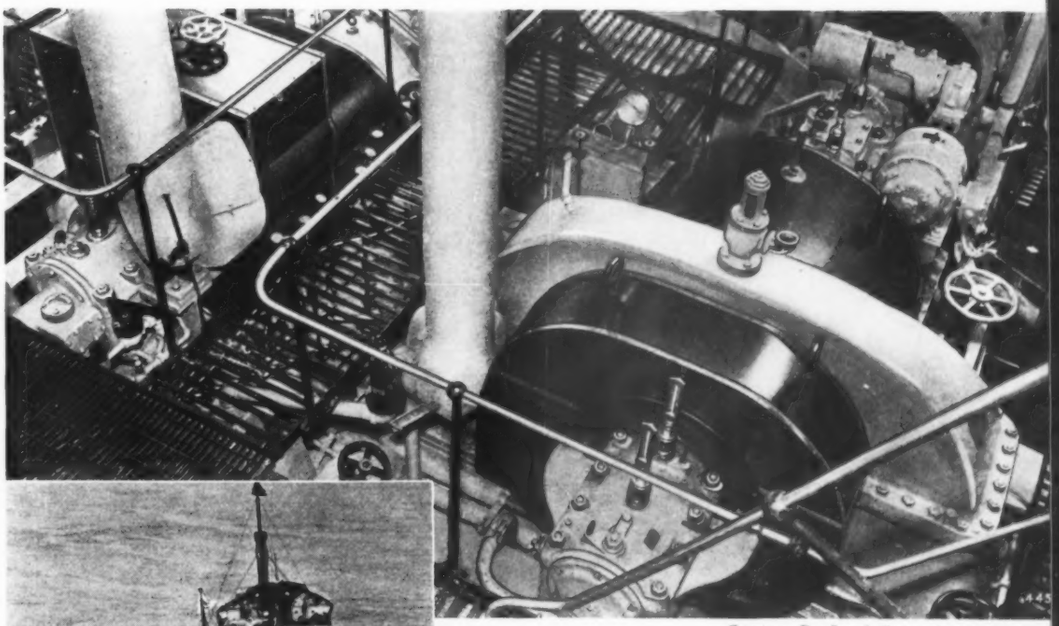
With the exception of slight variations due to construction in different yards, these ten vessels all have the same characteristics:

CHARACTERISTICS

Length, o.a.	450 ft.
Length, b.p.	440 ft.
Beam	66½ ft.
Depth	34½ ft.
Summer freeboard draft	27 ft. 11 in.
Deadweight capacity	13,000 tons
Loaded sea speed	12¾ knots

Boilers have been lifted out of the former position forward of the engine room, and hoisted up on a flat over the propeller shaft in the after end of the machinery space. Steam is generated by two Foster Wheeler boilers at a gauge pressure of 400 lb. per sq. in. at the superheater outlet. The steam temperature at full load is 750 deg. F., which does not vary more than 15 deg. F. between 25 percent load and 50 percent overload. The boilers have economizer sections but no air heaters.

In determining the boiler capacity allowance is made to take care of the Butterworth System without loss of pressure to the turbines.



Courtesy De Laval Steam Turbine Co.

Turbine installation on the Esso Bayonne.

Courtesy Foster Wheeler, Inc.

The main geared turbine propelling units are De Laval, and have a normal rating of 3,000 s.h.p. at 90 r.p.m. They are cross compound with double reduction gears, and differ from previous installations in that pinion speed of the high pressure turbine has been increased to 6,000 r.p.m., while the low pressure turbine turns at 5,000 r.p.m., both at 90 r.p.m. propeller speed. The two gear reductions are combined in a single casing, resulting in a saving of space and weight. Vacuum is maintained by a Foster Wheeler condenser. Boiler feed is heated regeneratively in three tubular heaters, two receiving steam at 100 lb. and 35 lb. absolute pressure at full load from connections of the high pressure casing, one receiving steam at six pounds absolute from the low pressure casing, with 70 lb. pressure on the suction.

Two De Laval turbine-driven boiler feed pumps consist of a velocity stage turbine driving a two-stage pump of the opposed impeller balanced type—designed to deliver 65 gal. per min. against 500 lb. pressure at 5,790 r.p.m. The boiler plant of the Esso BAYONNE is an excellent piece of engineering.

Motor driven auxiliaries receive current from a generator coupled to the low pressure intermediate gear shaft at sea, while for use in port and as standbys there are two 300 kw. generators driven at 1,200 r.p.m. by De Laval geared turbines running at 10,000 r.p.m. These units operate on steam at 375 lb. gauge and 725 deg. F. exhausting to 28¼ in vacuum. A De Laval centrifugal purifier with lead-lined bowl for lubricating oil, of a capacity of 150 gal. per hour is installed. The turning gear for the main unit includes a De Laval double reduction worm gear. The main thrust bearing is forward of the slow speed gear.

Other features of the Esso BAYONNE include cargo oil pumps with a maximum capacity of 9,400 bbl. per hour. Butterworth automatic tank gauges are also installed—a dial, covered by a bronze lid when not in use, showing the tank content.

TURBO-ELECTRIC Tanker Strikes New Note in Oil Transportation

WORLD'S largest all-welded ship, embodying a number of original features in application of modern engineering principles to marine construction, is the 18,500 tons deadweight J. W. VAN DYKE. This tanker is the 15th electrically-propelled ship designed by Atlantic Refining Company's engineers during the past 15 years—giving the company more electrically-propelled vessels than any other operator in the world. She was put into service during the first week of March, 1938, between Philadelphia and Gulf ports, establishing a speed of 14 knots on her maiden voyage down the coast—although service speed is 13.25 knots. She is the first American-built turbo-electric tanker, and it is reported that her owners expected a fuel consumption of 0.55 per s.h.p. hour; but operating figures have not been released.

Cargo capacity of the J. W. VAN DYKE is 156,000 bbl. She has an overall length of 543 ft., a beam of 70 ft. and a depth of 40 ft. Fuel bunkers hold 9,070 bbl.

A noteworthy feature is an engine room remarkably free of piping. The turbo-generator installation takes up a minimum amount of room. All machinery is either white enamel or chromium-plated, and the ladder railings are stainless steel. The electrical panel is of black bakelite finish.

Boilers are of simple header type, employing air preheaters, and have fully automatic combustion. Superheat control is used for the first time aboard ship.

The engine room is lighted with special diffused flood lighting fixtures.

Many of the engineering principles involved are taken from the shore developments of recent years which are applicable to marine equipment. Standard voltage and frequency have been applied for the first time to the main propulsion turbo-generator. This is a General Electric three phase 60 cycle machine, operating at 2,300 volts and supplying its power through a synchronous propelling motor, developing 5,000 h.p. at the synchronous speed of 90 r.p.m. For the first time in an American ship 650 lb. steam pressure is employed, at 835 deg. F. This is high for a marine installation.

Engine room auxiliaries are unusual, as they are operated by alternating current. Customary practice is to use direct current. All motors are explosion-proof and are totally enclosed. Under-deck auxiliary motors are of 440 volts, and this is also true of the two auxiliary turbo-generator sets. A novel feature is the operation of auxiliaries when running at a propeller speed of 90 r.p.m. at sea—all power is taken from the main turbo-generator, the 2,300 volts being transformed to 440 volts by specially designed transformers.

When propeller speed drops below 85 r.p.m., the 440 volts required for auxiliary power is taken automatically from the auxiliary turbo-generator, but when 90 r.p.m. is reached, the generator of the auxiliary set automatically becomes a synchronous motor and the auxiliary sets then run as exciters only for the main turbo-generator. Both main and auxiliary power are produced by the main turbo-generator, with the resultant economy of the main turbine. Thus, when this vessel is at sea there is but 20 ft. of steam pipe carrying the 650 lb. 835 deg. steam.

Arrangement of the engine room permits more space around the machinery, and more simplicity in piping than accomplished heretofore, due to location of the main turbo-generator on the 'tween deck, thus putting the turbine on the same elevation as the boiler steam header, and shortening connections between the boilers and main turbo-generator.

Auxiliary turbo-generators, the switchboard, and control equipment for the auxiliary motors, are also located on the 'tween deck. The main condenser, of the twin type having separate water boxes, has a divided hot well, and it is possible to shut down either side in case of emergency.

The main thrust bearing, which is directly after the main propelling motor, is novel for this size vessel. It is a complete journal and thrust roller bearing.

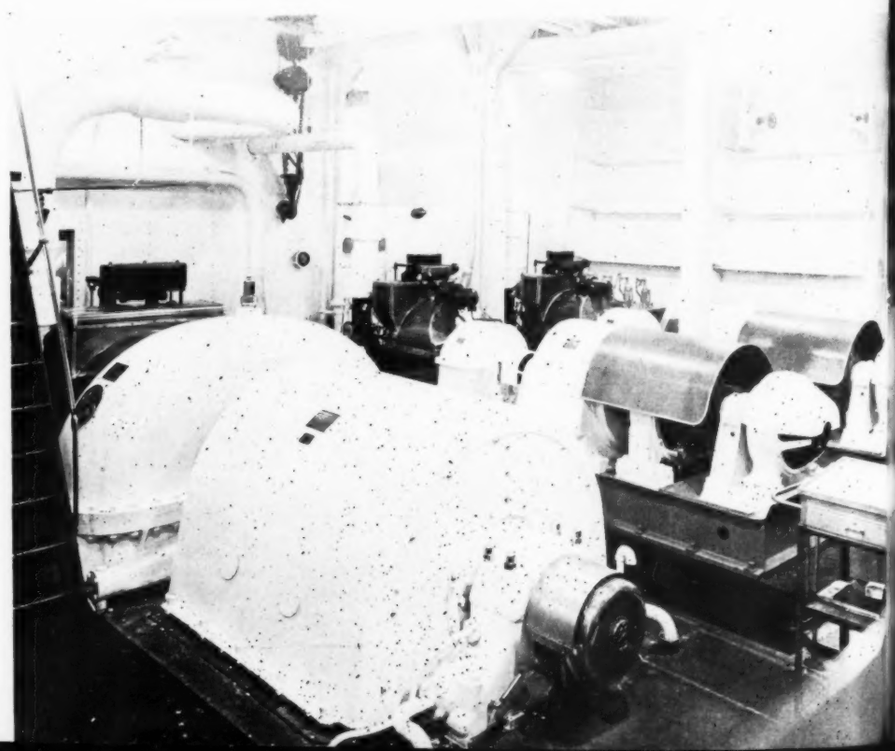
Steering of the J. W. VAN DYKE is accomplished by electro-hydraulic steering gear, using two motor-driven hydraulic pumps, and two automatic gyro-pilot after units. There are three methods of controlling this gear from the bridge: (1) through the gyro-pilot actuated by the gyro-compass, (2) through the same mechanism controlled by the hand trick wheel, and (3) by an independent lever control, which applies current directly to the auxiliary after unit, without inter-connection through any parts of the gyro system. So long as there is current aboard the ship, it can be controlled by any of these methods.

Perfect control is obtained on the electric hydraulic windlass, as the hydraulic pump motor runs at constant speed. Control is effected by means of hydraulic variation, and the windlass may be moved so slowly that the motion is almost imperceptible. The relief valve on the hydraulic motor overcomes danger of damage by inertia forces, an inherent difficulty in direct electric drive installations.

A departure has been made with the cargo pumps. Based on studies of rapid turn around, it was the management's order to the engineering and construction department that the cargo pumps be capable of discharging 15,000 bbl. per hour. Centrifugal pumps of vertical, or deep-well, type, with vertical explosion-proof motors located on deck, were installed.

This makes possible a simple pumproom amidship, and results in a feature never seen before. The pumproom is without wires

Right, night view of the J. W. Van Dyke—below, main turbine flat viewed from the switchboard.



or lights, and is illuminated by floodlights behind glass set in the deck. There are no stuffing boxes in the pumproom. The column that carries the shafting also carries the discharge liquid, and simplifies piping.

The J. W. VAN DYKE is equipped with the latest radio equipment, radio direction finder, and inter-communicating marine telephone system. Officers' staterooms and lounge and the crew's lounge are finished in cream side panelling and pale green ceiling with chairs and tables of stainless steel.

FRONT COVER

REPRODUCED on the cover of this issue is an oil painting of the J. W. VAN DYKE—the work of Walter L. Greene—through the courtesy of The General Electric Co.

Considered the most up-to-date vessel in service, the W. H. Berg was designed so that when she nears the end of her life she will still be modern. In her working spaces, as well as living quarters, there is a wholesome atmosphere.

MODERNITY Keynote of W. H. Berg

DESIGN of California Standard's latest vessels—W. H. BERG and H. D. COLLIER—embodies features which ensure personal comfort greatly in advance over general practice. Comfortable cabins are provided for all, whether officer or seaman—none of which is occupied by more than two men. Every cabin is fitted with deep spring-mattress berths, hot and cold water, porcelain wash-stands, forced draft ventilation, and even built-in aerials for personal radio sets. Harmonious color schemes of furnishings show the work of experts, while air-conditioning provides hot air for cold conditions and cold air for hot climates.

The commodious recreation room provided for exclusive use of the crew is a clubroom with upholstered seats, reading tables and large radio. In the steward's department the galley is the small-scale equivalent of that found on the finest passenger liners.

ISHERWOOD TANKER CONSTRUCTION IN 1937

Principal Isherwood-System Tankers in 1937

Name	Dimensions (Ft.)	Deadweight Cap.
Nishin Maru No. 2	537.0x74.0x48.6	21,800 tons
Emile Miguet	550.0x73.9x41.0	21,000 tons
Texas Sun	509.9x65.7x37.0	15,800 tons
Mobiloil & Mobilgas	486.3x68.3x36.9	15,515 tons
Esso Belgium	488.2x74.9x37.2	15,500 tons
Henry Dundas	490.1x70.0x37.0	15,200 tons
Regina	485.1x65.5x35.4	14,900 tons
Actor	470.0x65.1x35.3	13,000 tons
Esso Baytown	442.0x65.0x35.0	13,000 tons
Esso Bayonne & Esso Houston	442.0x66.5x34.5	13,000 tons
Wallace E. Pratt & W. H. Berg	442.0x65.0x35.0	13,000 tons
Realf	462.0x59.8x34.6	12,500 tons
Athos	455.0x61.0x35.0	12,500 tons
Gulfcoast, Gulftide, Gulfwave	426.3x64.1x34.0	11,426 tons
Bachaquero & Misoa	365.3x64.0x19.0	6,800 tons

ANY REVIEW of marine oil operations during 1937 would be incomplete without divulging statistics of the progress of Isherwood constructions—which have been applied to tankers with such success since 1908. According to figures received, out of 57 vessels aggregating 553,000 tons deadweight carrying capacity built to the Isherwood longitudinal, bracketless and combination systems and the Arcform hull form some 45, totaling 460,000 tons, were oil tankers. Of these tankers, 19 vessels aggregating 178,000 tons are to Arcform design, incorporating either the bracketless or combination system of framing.

Of particular note among the Isherwood tankers built in 1937 are the EMILE MIGUET (Cie Navale des Petroles), largest tanker built in France; the NISHIN MARU No. 2 (Taiyo Hogei Kabushike Kaisha); and the BACHAQUERO and MISOA (Lago Shipping Company), which set a new standard for shallow draft tankers plying the Aruba-Maracaibo route. These latter are the first Arcform tankers in this service and are of trunk deck type. Deadweight on service draft is limited by Maracaibo outer bar to 4,100 tons, although they can carry 6,800 tons on tropical freeboard. Trial speed was 12.65 knots, but service speed to maintain operation schedule is 11.25 knots.

OIL-ELECTRIC Drive and High Tanker Speeds

T. Orchard Lisle
M. Am. Soc. Nav. E.; M. Inst. Mar. E.

It is probable that a greater diversity of technical opinion exists in the marine industry than in any other business. The result is that oil-carrying ships are powered with a large variety of basically-different steam and Diesel propelling and auxiliary systems. Evidence on comparable operating results is still most conflicting.

Recently, a New York tanker-owning company purchased the old Shipping Board cargo ships DEFIANCE and TRIUMPH for conversion to tankers, which work is now under way. The new owners have decided to tear out the existing oil-electric machinery and replace it with geared-turbine drive. These two 10,500 ton d.w.c. vessels, together with their sister ship, COURAGEOUS, were originally built with geared-turbine power, but were too slow to maintain their place in America's maritime trade.

When they were converted to oil-electric power in 1928, the Board's naval architects, Admiral Taylor and W. F. Gibbs, produced ships which gave trial and initial voyage performances unequalled before or since by any commercial craft afloat, i.e., 16 knots with 4,500 maximum s.h.p. Certain mechanical phases of their machinery gave faulty operation causing them to be frequently laid up for repairs. The ships were found too large for profitable cargo-liner service to the Far East, and eventually they were sent to the mooring buoy. Yet all indications were that the form of installation was basically sound, although at that time it was a major experiment—valuable, but an experiment.

Performance data is available for the first of these three ships to be converted in 1928. The secret of her performance which no other ship of the same tonnage and power has ever been able to match, except the two sisters, lay in the low propeller speed of 60 r.p.m. which the special principle and design of the propelling installation made possible. In order for proper comparisons to be made it must be mentioned that her loaded displacement was 15,140 tons, light displacement 4,640 tons, deadweight capacity 10,500 tons, and her net-cargo capacity 596,627 cu. ft., including a deep tank not required for fuel. Fuel bunker capacity was 1,159 tons. No boiler water was needed.

On official Shipping Board trials in 1928 with her machinery developing 4,500 s.h.p. maximum at 64 r.p.m. this vessel attained a speed of 15.97 knots for 29 miles. Over the full 60-mile course she averaged 15.34 knots, also at 64 r.p.m. This compares with her trial speed of 10.91 knots when she was a steamship of 2,654 s.h.p. at 80 r.p.m. On the first leg of her maiden voyage after conversion (from New York to Baltimore) she averaged 14.6 knots loaded, and developed 3,400 s.h.p. On trans-pacific voyages her average was about 13 knots on 26 ft. draft, which was the speed desired by the owners. On one run of 4,788 sea-miles she averaged 13.68 knots at 60.95 r.p.m. with a loaded displacement of 14,374 tons. On another trip in ballast she averaged 13.96 knots with her propeller turning at 50.89 r.p.m. On one of her long voyages, 28,512 miles, she averaged 13.03 knots at 60.27 r.p.m.

The trial results are nothing short of remarkable, as any tanker operator will recognize. Especially as her oil fuel consumption at sea was only 21 tons per day, and three tons per day in port, compared to 35 tons and 14 tons, respectively, when equipped with her old steam power and before she was lengthened 11 ft. both fore and aft and fined to give her a better block co-efficient.

At the present moment the two sister-ships are both being re-equipped, and the new geared-turbo plant will develop 5,000 s.h.p. maximum continuous, or for normal running 4,500 s.h.p. at 125 r.p.m. propeller speed. Her owners expect a loaded ship speed of 14.5 knots; but in view of the much faster propeller revolutions the results will be extremely interesting. The writer estimates that her fuel consumption will not be less than 28-30 tons per day at sea and 15 tons when in port discharging cargo.

When oil-electric drive was first considered for these boats by the Shipping Board, it was conservatively estimated that to attain 13½ knots by direct drive (such as a single-screw Diesel engine turning at a speed consistent with reasonable weight) it would require no less than 5,600 s.h.p., including 850 b.h.p. in auxiliary units. This would mean considerably greater machinery weight and a much larger investment than the extra cost of the electrical transmission unit finally adopted. With the latter no auxiliary sets were required other than a 55 h.p. lighting plant, because when in port one of the main engine-generators was used to provide power for handling cargo. The total machinery weight was 930 tons, and this could have been reduced had the decision to adopt Diesels running at 250 r.p.m. not been made. Lighter oil engines turning at somewhere between 400 and 600 r.p.m. would have affected a large saving in weight and cost.

One reason for the fuel economy of these ships after conversion was that speed was varied by cutting-out units. No matter what the ship's speed, one, two, three or all four of the main engines were always turning at their economical revolutions; whereas with any form of steam power the less steam or pressure being delivered, the higher is the fuel consumption ratio.

Aside from the sound general arrangements from the naval architectural point of view, a number of engineering errors appear to have been made in designing and constructing the oil-electric machinery installation at the time of the first conversion of these ships. As stated, the troubles which arose resulted in long lay-up periods for repairs and, generally speaking, the owners and operators were soon disappointed. But we again must remember that ten years ago it was an experiment. These factors have drawn attention away from the basic soundness of the principle involved, and away from the fact that the difficulties were purely mechanical and not fundamental. The mechanical troubles damned the entire machinery.

In discussing these vessels, the writer, who attended the trials as an independent observer, merely seeks to draw attention to the remarkable results that can be secured through judicious use of reasonably high-speed oil engines driving a large slow-speed propeller through electrical transmission. With tankers of low block co-efficient this is very important. In the ten intervening years since the DEFIANCE, TRIUMPH and COURAGEOUS put to sea following their initial conversion, there have been many noteworthy developments in oil engines and electrical equipment, so that today there is no need whatever for repetition of the mechanical troubles which arose in these vessels. Recent manufacturing developments, too, will reduce initial costs.

Everything points to the soundness of the basic engineering principle involved. With the oil-electric system, the high speeds required with today's tankers can be attained with lower power and cost than by any other means.

Somewhat similar results can be obtained by substituting reduction gears for the electrical transmission; but in this case auxiliary oil-engine generating sets of considerable extra horse-power must also be installed for port duties. And, of course, it presumably is possible and practical to adopt a similar propeller speed with double-reduction geared turbines.

Foreign Oil Legion

Frosty Martin and Johnnie Gallagher watching a Burman bailing a hand-dug well in Yenangyaung oilfield, Upper Burma (see main story on page 42).

DR. JOSEPH HUNCK, Hamburg economist, has completed his "History of Tankers Under the German Flag" for Waried Tankschiff Rhederei G.m.b.H. (affiliate of Jersey Standard) which is to be published in the near future. The book is understood to contain considerable unpublished information and illustrations of the early experiments of Wilhelm Riedemann, of Deutsche Americanische Petroleum Gesellschaft, carrying the story right up to the fine modern tankers now building in Germany. Dr. Hunck is at present working on a tanker picture-book with explanatory words.

PEDRO LOPEZ, son of the HON. ALFONSO LOPEZ, president of Colombia, sailed from New York for Puerto Colombia on board the SANTA PAULA. He has been studying for several years in London and more recently in New York.

W. H. SULLIVAN, recently-appointed president of Gasoline Products Company, Inc., has announced an enlargement of the current program of research. New requirements are arising and the company has doubled its program in order to anticipate them. Research is being focused particularly on possibilities of increasing octane number of gasoline and yield of satisfactory distillate fuels beyond present levels. Mr. Sullivan first started in the oil business with The Texas Company in 1920, resigning after ten years to join Gasoline Products as secretary-treasurer. Other recent personnel changes in the company were the election of PIKE H. SULLIVAN as vice-president and of E. F. LIEBRECHT as secretary; the latter will also function as general patent attorney.

AKURA OGURA, son of president FUSAZO OGURA of Ogura Oil Company, Tokyo, and mechanical engineer for the firm's several refineries, arrived in Los Angeles on board the tanker OGURA MARU March 11th en route to Philadelphia. Accompanying him was SENSUKE MORIYA, chemical engineer for the Ogura interests. They are at present conducting a two months' study of North Atlantic oil refineries after which they will make a similar survey of Pacific Coast plants.

KOSAKU KUDO, chief engineer of the Imperial Japanese Navy's oil depot and refineries at Tokuyama, returned to Japan from San Francisco March 17th on board the liner TITIBU MARU. He has just completed an exhaustive study of petroleum production, refining, storage and shipping practices in Southern California.

RENE PERRIN, director of the Compagnie Francaise de Raffinage, together with ALFRED S. WOLFNER, consulting engineer to the firm, have been visiting Iraq and Iran. Compagnie Francaise is the concern which refines Iraq crude in France. The two officials paid a short visit to Baghdad during the latter part of February, and then proceeded to Abadan where they inspected the refinery of Anglo-Iranian Oil Company, Ltd.—reputedly the largest in the world.

FRANCIS W. RICKETT, noted oil concessionaire, and BERNARD E. SMITH, New York broker, visited Mexico City together during the latter part of March and early April. It is understood that while closeted with president LAZARO CARDENAS the two men offered him large contracts for government produced oil—at prices well under the world market. Mr. Rickett established his reputation in negotiating oil concessions

Bart W. Gillespie en route up the Rio Pachitea, Peru, to Agua Caliente, where he is on location for Cia. de Petroleo Ganzo Azul (Blue Goose Oil Company).

when he obtained a large oil-bearing area in northern Iraq for B. O. D., Ltd. and later received worldwide notoriety in connection with the concession he obtained in Abyssinia on behalf of Standard-Vacuum in the face of MUSSOLINI's pending conquest of that country. More recent among Mr. Rickett's activities have been negotiations for the remaining area of Iraq, some 60,000 sq. mi., which is larger than either the B. O. D. or I. P. C. concessions. This third concession is being sought by several groups and lies across a latitude of 32 degrees, extending east and west to the frontier, and goes down to the southernmost point of the country.

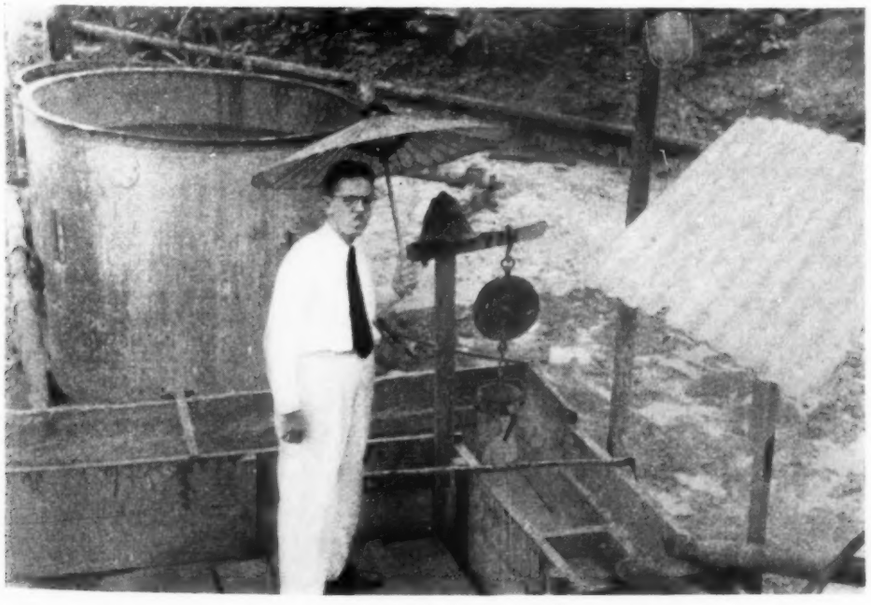
Capt. W. L. Beck, chief of staff, Fourth Naval District, presents to Capt. Everett Van Pray, commander of the J. W. Van Dyke, the U. S. merchant marine naval reserve flag to be flown by that vessel to mark its acceptability as a naval auxiliary in time of war and the fact that the master and 50 percent of the other officers hold commissions in the naval reserve. The J. W. Van Dyke is the first vessel ever warranted to fly the naval reserve flag prior to her maiden voyage.

FREDERICK G. CLAPP and E. GARDNER CLAPP, while driving from the fields of Inland Exploration Company in Afghanistan to those of Amiranian Oil Company in southeastern Iran during January, were marooned by floods not far from the railway through Baluchistan. They arrived in Zahidan, temporary headquarters for many of the Amiranian geologists, early in February. Gardner Clapp, who is employed on some of the technical and administrative phases of the surveys, sometimes at Zahidan, has returned to the company's office at Kabul, which is under the management of REX VIVIAN.

Frederick Clapp is proceeding northward through several sedimentary basins in which the company is operating, inspecting the results of the recent surveys and supervising a group of parties headed by himself, LESTER THOMPSON, DR. HUBERT G. SCHENCK and HENRY HOTCHKISS. Mr. Thompson is in local charge for Amiranian while Dr. Schenck is conducting paleontological researches through the great thickness of Lower Tertiary and Upper Cretaceous sediments in that part of the country. Mr. Hotchkiss, until recently assisted by H. A. AFSHAR, is making detailed surveys on some of the attractive structures. Mr. Afshar, until this winter in the geological department of Amiranian, has joined the production department to assist in drilling the first test well now being commenced. Chester R. Thomas and O. C. Olson are at present en route for southern Iran to assist in the geological surveys.

DR. FRANK REEVES and WALTER P. WILSON recently returned to Meched from making comprehensive surveys for Amiranian in the northern part of the great Iranian deserts. Travel had been by both car and camel. The party plans to start early in the spring on studies in the favorable areas along the Iranian-Afghan frontier and may continue its work into the vast areas in Afghanistan held under concession by Inland.

Geologists of Inland, who operated during the autumn and early winter in the anticlinal areas of northern Afghanistan, moved south for the winter season. HOWARD M. KIRK has lately been surveying the southern Afghan desert regions on camel back while ERNEST F. FOX and BENNETT FRANK BUIE are working out from Farah, not far from the Iranian frontier. HENRY C. REA has been assigned to work in the promising area not far from Kandahar in southeastern Afghanistan.



Prof. John F. Dodge, instructor in petroleum engineering at the University of Southern California, inspecting a wildcat well near Pankhalin Brandan, Sumatra. Prof. Dodge has been touring the world for several months and included on his itinerary the oilfields of Borneo, India and Japan.

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Petroleum Industry. Edited by Dr. O. W. Willcox

GEOLOGY

Oriskany in West Virginia—Robert C. Lafferty, in BULL. AM. ASSOC. PETROLEUM GEOLOGISTS, vol. 22 (1938), No. 2, pp. 175-188.

The Oriskany sandstone is a sheet deposit in West Virginia and underlies approximately three-fourths of the state from its outcrop along the eastern edge before it thins and disappears in the western part. The sand ranges in thickness from probably more than 200 ft. in the northern part to an average of 40 ft. in the producing fields. A definite water table is present on the eastern margin of the gas belt. This is apparently trapped water, as rock pressures in the Kanawha County fields do not indicate hydrostatic control. The sand varies from coarse-grained (1.+ millimeter) to fine-grained (0.1 millimeter) sand. Normally, the upper part of the sand is much coarser than the middle or lower section; however, alternate coarse- and fine-bedded sand is common and is suggestive of cross-bedding. Calcium carbonate is the main cementing material in the sand, although near the western limits of deposition silica is the predominating cementing medium. Porosity in the proved fields ranges from 6.8 to 11 percent. Open flows in the various fields range from 46,000 to 22,000,000 cu. ft., with rock pressures varying from 1,100 to 1,940 lb. Carbon dioxide and distillate are present in the gas in these fields. The carbon-dioxide content of the gas increases in wells high on the structure, while the distillate decreases. To date, 21 dry holes and 124 gas wells have been completed, and a daily open flow of 625,725,158 cu. ft. developed. Anticlinal structure is of primary importance for production, but proper sand conditions are also necessary. Due to convergence, anticlines, as expressed on the deeper horizons, are shifted from their surface or shallow subsurface location. The reflection seismograph has been a very valuable aid in checking the positions of these axes and will, no doubt, help materially in areas where water is thought to be present.

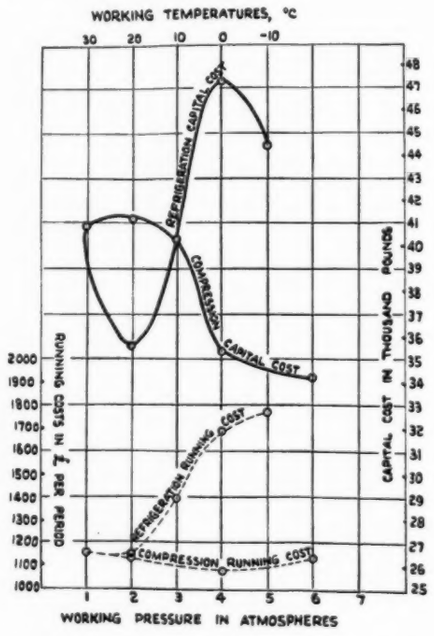
Where productive in the Kanawha County fields, the Oriskany sandstone varies from 11 to 60 ft. in thickness with the pays from one foot to 28 ft. below the top of the sand. Where the sand is of greater or less thickness it has proved non-productive. This critical productive thickness is probably due to shore-line conditions during deposition.

NATURAL GAS

Cost of Oil Absorption Plant for Natural Gasoline Recovery at High Pressure and Low Temperature—A. H. Nissan, in JOUR. INST. PETROLEUM TECHNOLOGISTS, vol. 24 (1938), No. 172, pp. 69-111.

This paper gives an engineering calculation of various types of oil-absorption plants, assuming a reasonable composition of the initial gas and the final product. One series of these plants is designed to operate under pressures varying from 1 to 6 atmospheres at a constant temperature of 30 deg. C.; another series is designed to work under a constant pressure of 1 atmosphere and at temperatures varying from —10 deg. C. to 30 deg. C. The operating conditions for each of the eight systems considered are calculated in much detail.

Also, the capital cost and the operating costs of the eight different designs are calculated and plotted; these cost calculations are comparative only, as real costs will depend on time, place, and circumstance. (See accompanying diagram).



The end result of these calculations is the quite definite conclusion that the running costs of a compression system have a minimum value at four atmospheres absorber pressure, and this is about the same pressure that is most favorable from the standpoint of capital cost. On the other hand, with the refrigeration systems the running costs show a minimum for operations at the standard temperature of 20 deg. C. from which point the curve of costs rises steeply. The capital costs also show a minimum at this same point.

Hence the choice is figured to lie between an absorption plant running at 20 deg. C. and a pressure of one atmosphere, and a plant operating at 30 deg. C. and four atmospheres. So far as capital costs are concerned these calculations show no practical difference in favor of either. As to operating costs, there is a calculated difference of approximately six percent in favor of the compression system. The natural preference of the practical man would be for a plant working at a low pressure as against one working at four atmospheres; whether a prospective economy of six percent will overcome that preference is something to be decided by the general circumstances of the case.

DRILLING

Use of Hydrogen in Diesel Engines—P. M. Sanders and E. K. Wenlock, before DIESEL ENGINE USERS ASSOC., December, 1937.

In the course of a report on the influence of the Diesel engine on the cost of motor transport the authors state some results of tests on the use of hydrogen as a supplementary fuel in Diesel engines. The tests were made on an ordinary 100 h.p. engine which had a brake efficiency of 32 percent and consumed 0.44 lb. of oil per h.p.-hour; the cost of oil per hour was 5s. 5d. The hydrogen gas used in the tests was produced by electrolysis under high pressure at a cost of 1.55d. per 2,650 calories of heat value (with electric power at 0.25d. per k.w. hour). By injection of hydrogen along with the oil in an amount equivalent to 10 percent of the total calories consumed by the engine, there was effected a saving of 26 percent of the cost of the oil, which amounted to a saving of 3d. per hour in operating the engine; with electricity at 0.2d. per k.w. the saving would be 5d. On the other hand, leaving the cost of electricity at 0.25d. but increasing the proportion of hydrogen calories to 20 percent the saving would amount to 8d. per hour.

It was also found that Diesel engines operated with injection of hydrogen functioned very smoothly, with a cleaner exhaust and a reduced consumption of lubricating oil.

Recent Advances in Knowledge of the Colloidal Properties of Clay Suspensions and Gels—Charles E. Reed, in PETROLEUM TECHNOLOGY, vol. 1 (1938), No. 1, T.P. 871; 10 pages.

Napoleon is credited with the saying that an army travels on its stomach; it might also be said that the oil man reaches his goal through mud—driller's mud. This important fluid rightly demands most careful consideration, and the petroleum engineer cannot know too much about it. The difficulty has been to gain an insight into the real nature of clay suspensions so that their behavior can be controlled.

In this paper the author gives an illuminating review of what is known about clays and their natures as colloidal suspensions and gels. It is that the ultimate particles of clay consist of platelike crystallites stacked upon each other like a pack of cards. The high swelling, high viscosity, and pronounced gelation tendencies of bentonite as contrasted with kaolinite are explained by the water molecules forcing their way between the cyrstallites and prying these apart, with resultant formation of platy particles having unusual capacity to interfere with each other and with the flow of the liquid in which they are suspended. This interference of the particles may develop a gel in which each particle is no longer free of its neighbors but requires a certain force to dislodge it from a position in the gel structure into which it has become locked. Those clay fractions consisting of the finest particles show the highest rate of gelation. Metallic clays are known to undergo an irreversible increase in viscosity and rate

of gelation upon heating to moderate temperature levels as contrasted to hydrogen clays, which show no significant changes in structure under the same circumstances. (This helps to explain the role of alkali and sodium silicate in drilling muds—ED.)

The key to interpretation of these facts lies finally in recognition of the mechanism by means of which the ultimate platy particles become firmly locked into place in a structure. It is possible to account for the facts on the basis of mechanical interference of platy particles if the existence of very large ratios of length and breadth to thickness of the ultimate plates be assumed. The facts may also be explained by the repulsion-attraction theory which demands assumption of the existence of far-reaching forces of attraction and repulsion to bind the particles into equilibrium positions from which they have no tendency to depart. In the final analysis, the two theories differ only in the average distance they assume between particles in the gel and both are fruitful working theories at present.

Automatic Sampling of Drilling Mud—L. G. E. Bignell in OIL & GAS JOUR., vol. 36 (1938) No. 40, pp. 57-58.

The importance of obtaining representative samples of the formations penetrated by a rotary drill is recognized, but the actual methods used in taking these samples leave much to be desired. It is mostly left to the judgment of the driller, whose decisions as to when samples should be taken are often subject to error.

In order to eliminate this personal equation it would be desirable to have a mechanical device which would act automatically and regularly. Such a device is the subject of this article. It consists of a wheel which is turned by the liquid stream flowing in the mud ditch. This wheel carries a spoon which scoops up a load of mud and cuttings. The mud is automatically washed out and the screened cuttings are available for examination. By using duplicate pans and screens it is possible to remove mud and cuttings at any time.

The cuttings caught on the screens are tested for oil by a benzol extraction, which is very sensitive to traces of oil, or by centrifuging. The samples are also tested for gas. Ordinarily, Gulf Coast muds contain 0.25 percent of gas; when a gas sand is penetrated this will increase to three or four percent and fall rapidly after the sand has been passed.

It is said that, with this automatic sampler in use, coring may be dispensed with until the producing formation is reached.

How and Why of Oil Well Shooting—Paul F. Lewis, in OIL WEEKLY, vol. 88 (1938), No. 13, pp. 45-53.

Use of explosives in the petroleum industry to increase the production of an oil well is based on the same principles as in other industries (quarrying, for instance) but until recently the application of these principles to oil well shooting has been more or less misconceived.

One of the commonest misconceptions is that the explosive column must cover the entire thickness of the pay formation from bottom to top, regardless of the amount of explosive or the diameters of bore hole or torpedo. This idea is based on the assumption that, whatever the effect of the explosion, such effect would radiate from the center line of the hole out in horizontal planes and thus disrupt the face of the oil-bearing formation throughout its entire section.

Experience has taught that the force of an explosion always follows the line of least resistance, and in an oil well this line of least resistance is always upward. To obtain the maximum effect the explosive should be concentrated at the bottom of the pay so that its effect is to shatter the entire pay sand without affecting the bore hole above the pay and without damaging the casing point and, as a general rule, without damaging the casing above the pay.

The point is illustrated as follows:

If there were 10 ft. of pay to shoot and it was elected to shoot it with one quart per foot, that would necessitate the use of 10 ft. of 2¼-in. shell. About all that could be expected from the primary radial action of that shot would be a slight local pulverization of the wall to chip or scrub it, and a relatively narrow fracturing radius. If, however, the same quartage were contained in a 5-in. shell there would be four times as much explosive per foot of hole and consequently the surrounding walls would be struck a blow which would reach out to tap the oil stratum correspondingly harder.

The experience of a large operator in the Panhandle who shot 10 wells by the new concentrated-shot method, wherein the explosive is concentrated in the lower two thirds of the pay, is that the new practice consumes 6.19 percent less explosive per well, the decrease in shooting costs averages 6.75 percent, the average increase in initial potential of wells has been 19.45 percent, and the average gas/oil ratio per well has been reduced 18.94 percent. There has been placed 26.79 percent more explosive in the lower two-thirds of the pay than was formerly used in the same footage. It is further reported that by this practice of concentrated shots, oil strings of casing can be set from 10 to 20 feet closer to the top of the oil pay than in the past, so that much free gas, and in some cases troublesome shale breaks, can be cased off and better completions of wells are permitted.

Drilling Past 13,400 Ft.—L. P. Stockman in OIL & GAS JOUR., vol. 36 (1938), No. 41, pp. 65-78.

Continental Oil Company has established a new world record for depth in drilling with a wildcat well in the Wasco district of Kern County, Calif. This is the first well ever to pass 13,000 ft.; the intention is to carry it still deeper (at least to 13,500 ft.) in the hope of encountering the Rio Bravo sand, which is known to be productive in other districts.

A remarkable feature in connection with the drilling of this well was the ease with which drilling operations were conducted, even at the greatest depths. Drilling to 13,315 ft. consumed 239 days, including 44 days lost due to mechanical trouble. The going was hard at times, and at 12,879 ft. a temperature of 255 deg. was encountered. In spite of the depth and the rate at which footage was made the hole remained unusually straight. The maximum deviation from the vertical was only 22.1 ft. and a survey taken at 11,573 ft. indicated that the bottom of the hole was almost directly beneath the derrick floor. This close adherence to the vertical was a contributing factor of no little importance in reaching the great depth attained.

A string of seven-inch casing was landed at 11,573 ft., requiring only eight hours and 20 minutes to land the entire string, with a little less than two hours to accomplish the subsequent cementing job. In drilling, a total of 72 bits and 49 core bits were used.

While ordinarily the economics of a 13,000 ft. well might be questioned, the risk here has appeared worth taking in view of the objective, which is the highly promising Rio Bravo sand. The location was chosen on the basis of seismographic work that indicated a high.

Squeeze Cementing—C. P. Parsons, in OIL WEEKLY, vol. 88 (1938) No. 12, pp. 36-38.

Squeeze cementing means that cement slurry is forced, by pressure, into or against a permeable formation or through perforations in casing and liners for the purpose of shutting off water or for reducing gas/oil ratios.

Squeezing of cement is old but there have been recent developments in method, technique and cement which are producing remarkable results. Cement slurry is being squeezed indiscriminately against both the oil bearing and water bearing portions of a producing formation without shutting off any of the oil but shutting off the water.

Cement slurry is being squeezed indiscriminately against both the oil bearing and gas bearing portions of a producing formation without shutting off the oil but shutting off the gas.

In certain areas where new wells produce with an excessive gas/oil ratio, cement slurry is being squeezed against the producing formation before the wells are completed for initial flow.

These striking results have not been flukes nor just a few jobs scattered here and there. There have been several thousand jobs during the past year with squeezing pressures up to 5,600 lb. per sq. in., and averaging around 3,000 lb., without shutting off the oil.

Among the developments which have led up to the present form of squeezing are the following: better cementing technique; better cementing equipment to handle high pressures; special cements to set slowly under high temperatures; self-sealing fibred cements; packers and back pressure valves; bridge plugs; electrical logging; wall scrapers; and gun perforators.

One of the essential elements in the success of present squeezing is that any obstruction at the face of a formation is first broken down by pumping water or acid into the formation at whatever pressure is necessary to overcome the obstructions.

In this paper, which was presented before the spring meeting of the Mid-Continent production division of the A.P.I., the author gives many practical hints on the application of squeeze cementing in particular cases.

OIL WELL OPERATION

Applied Back Pressure as an Agent in Control of Paraffin—Frank B. Taylor in OIL WEEKLY, vol. 87 (1937) No. 13, pp. 18-21.

Controlled back pressure is effective in retarding the formation of paraffin in Texas Panhandle wells. A number of operators have equipped pumping wells with pressure manifolds, and through no more than ordinary attention, apparently have been able to obtain at least a partial control over the inter-tubing formation of produced paraffin. The installation is simple, entails almost no maintenance, and is quite low in initial cost.

Proponents of the principle admit limitations for the application. It is not a cure-all. But at the same time, continuous operation of a pumping well for 10 months without a paraffin job when using back pressure equipment, as compared with a 60-day cleanout requirement of the same well prior to use of back pressure equipment, certainly constitutes a strong case in favor of pressure control. And this mentioned instance is by no means either exceptional or outstanding.

A manifold that is functioning correctly effects the retention of relatively large volumes of crude in the tubing at all times. This tubing charge also supports a volume of paraffin that under ordinary operation would be deposited near the top of the string. Under back pressure conditions it is indicated that the held paraffin is in a state of suspension solution within the fluid column. By opening the regular valve of the back pressure manifold daily the tubing charge is reduced to normal pumping status.

This purging of the string of tubing through the release of held back pressure allows the well to clean itself swiftly, carrying paraffin held in the fluid column out through the lead line and the pressure manifold. The swiftness of the exhaustion of pressure in the tubing when it dumps in this manner, also produces a disruption of paraffin clinging to the walls of the tubing and allows this quantity to be discharged from the tubing string. Making this action even more complete is the fact that the paraffin deposited under back pressure conditions is probably not as adhesive, or solid, as that deposited under normally pumped production.

Flow of Oil-Gas Mixtures Through Unconsolidated Sands—L. S. Reid and R. L. Huntington, in PETROLEUM TECHNOLOGY, vol. 1 (1938), No. 1, T.P. 873; 14 pages.

Obviously, the low cost of producing oil during the flowing life of a well makes it desirable to obtain production by natural flow as long as possible and to effect a maximum recovery of oil and gas by the utilization of reservoir energy through efficient methods based upon a thorough knowledge of reservoir characteristics. Despite the extensive research that has been carried out, there is little information available on the behavior of oil and gas mixtures flowing through reservoir formations. This makes it impossible to predetermine the optimum operating conditions for flowing wells.

As a contribution to a solution of the problem the authors made experiments on Wilcox sand which show that the pressure gradients, when maintaining both steady-state and unsteady-state flow of an oil-gas mixture through an unconsolidated sand body, very closely approximate the gradients obtained experimentally from a carbon dioxide-water system by Wyckoff and Botset and the theoretical consideration developed by Muskat and Meres. The shape of these curves plainly demonstrates the importance of effective permeability in heterogeneous fluid flow through porous media.

Further analysis of the data indicates that, in order to obtain the maximum degree of flow efficiency and to maintain minimum gas-oil ratios in the reservoir, the flowing bottom-hole pressure should be equal to at least 50 percent of the shut-in bottom-hole (or saturation) pressure.

The productive history of the reservoir under various conditions of unsteady-state flow shows a rather remarkable similarity to that obtained in actual practice. The effect of the presence of a gas cap on oil production is shown, and also the variation in decline of oil and gas rates and gas-oil ratio trends for different rates of withdrawal.

Data obtained from these various conditions of unsteady-state flow suggest that the ultimate yield of oil and gas is some function of the rate of withdrawal from the reservoir. The existence of an optimum rate of withdrawal has been indicated, since the ultimate recovery may be reduced by producing the reservoir at a very low rate, as well as at a very high rate.

Loading Explosives into Wells by Pressure—F. R. Cozzens, in OIL WEEKLY, vol. 87 (1937), No. 12, p. 44.

Every producer of crude oil or gas has his own pet method of shooting newly drilled wells. Strict adherence to the various pet formulas has ruined at least a third as many wells as were benefited, and many tons of explosives have been wasted in an effort to correct conditions which existed only in the operator's mind. Nowhere else is this result more plainly marked than in the shallow-sand fields of Ohio and West Virginia.

An efficient method is to force explosives into the rock by outside pressure. When an air compressor is available on the lease, the loading process is accomplished by releasing the required amount of liquid explosive into the well by means of a specially constructed shell with a trap opening in the bottom. About one tenth more explosive is used than would otherwise be necessary in a sand-face of a given thickness. After the empty shell has been withdrawn, and the detonator lowered on the end of an insulated connecting wire, the operator pushes a cap down upon the charge. The cap is a wad of felt or bulky material, and its purpose is to confine floating particles of the explosives. He next pours in sufficient water to anchor the charge, the usual amount being three barrels. A two-inch air line is then connected with the compressor, and air is forced down the hole with all possible speed until pressure at the casing head registers 800 to 1,000 lb. At this point, pressure is released, full volume from the casing, connections removed, and the charge fired elect ically.

Where air compression is not available, the necessary pressure is applied with the drill. The cap or binder is forced down upon the charge in the regular manner, but instead of pouring in water, the necessary anchor is composed of sand, sawdust, or finely screened gravel. About 200 lb. of such anchor is used. A buffer made of rubber or a block of wood is clamped over the drill-bit, and the drill applies pressure until the anchor is tamped hard and firm. Detonation is accomplished by placing electric blasting cap connected to shot wire in a three-foot section of wood, the end of which is sharpened to a point. These detonators are constructed on the job and are lowered down the well by connecting wire, pointed end down. The drill, with rubber buffer attached pushes the point of detonator through the anchor until it contacts the explosive. An electric spark sent down the wire from an outside battery fires the charge.

Water Problem in the East Texas Field—George Weber, in OIL AND GAS JOUR., vol. 36 (1938) No. 42, p. 21.

At present the outstanding feature of operations in the East Texas field is the rapid encroachment of salt water on the west side of the field. Every week shows an increase in the number of wells affected, and this progressive advance of the salt water raises two serious problems, the one threatening the life of the field, the other the ultimate production of recoverable oil.

This condition calls for an intelligently conceived and well executed program for combatting the salt water. The first and most logical step will be to stop the inflow of the water, which besides being a nuisance in itself greatly helps to lower the bottom-hole pressure, which declines in proportion as either water or oil is removed from the formation.

The problem is aggravated by the existence of numerous marginal wells, such as those that are producing Woodbine water. These operators, in order to make their allowable production, are forced to pump a larger volume of the oil-water mixture, which causes a more rapid movement of water and oil through the sand. Where this rate of movement exceeds the rate at which the oil passes through the less porous sections of the formation, water from the lower depths will drive ahead and trap oil that might be recoverable if the well were operated at a slower rate; hence there is in prospect a tremendous loss in ultimate oil production.

The one outstanding remedy for the situation lies in the plug-back or squeeze job, but the difficulties in the way of a general application of this remedy are enormous. Wells in completely flooded areas are producing water in great quantities; their owners would not profit from a plug-back or squeeze job, and they remain a constant damaging influence on the general bottom hole pressure. It is also problematical whether the cost of a plug-back or squeeze job would be justified in the case of a thin oil sand.

Experience with squeeze jobs in this field indicate something of what might be accomplished. Of 100 wells plugged back to shut off salt water 45 were 100 percent successful, 30 were partly so, and 25 were not improved. The non-success in these latter cases is ascribed to mechanical failures, poor cement jobs, improper handling and subsequent damage. Skillful handling would no doubt considerably increase the number of successful jobs.

This outstanding threat to the life and ultimate oil recovery of the East Texas field thus comes from the marginal producers who have little or no incentive to remedy conditions in their wells that will eventually inflict loss on all their neighbors. At any rate, the latter should bestir themselves and do whatever research and experimentation is needed to put the technique of their own squeeze jobs on the surest possible basis. It is estimated that 4,000 squeeze jobs will be necessary in 1938 to correct the situation.

(Note: This is a large-scale illustration of the evils arising from failure to operate an oilfield as a unit. —ED.)

Acidizing Core Samples—L. C. Chamberlain, Jr., in OIL WEEKLY, vol. 88 (1938), No. 12, pp. 20-34.

The acidizing of producing formation is now an accepted practice wherever oil and gas are found in a predominately limestone formation. The practice has not yet grown out of its infancy and there are many aspects of the matter that have not yet been completely thought out. In particular, there is a lack of correlative data offering a practical means of rating the treatability of a given formation by reference to a general, workable index.

It may be remarked that acidizing of cores is practiced not to prove that acidizing increases their permeability, nor to vindicate the practice of acidizing, but as a means to improve field service by observation and comparison of the results obtained. By this method the best type of treating acid can be chosen; difficulties in treating may be recognized in advance; and the engineer, being forewarned, may be forearmed with means to produce results.

In the course of his investigations to discover the real significance of acidizing the author tested cores from most of the fields in which acidizing is practiced. Early in this study it was apparent that some comparatively simple means of rating samples for treatability was acutely needed. No quick reference was applicable, as a breakdown of the information gained did not always give a true picture of the results obtained by acidizing. To fill this need the acidizing index was evolved. This index is not necessarily a function of the type of treatment given but is more dependent upon the chemical and physical characteristics of the producing formation.

The acidizing index is obtained from the results of tests on cores, and is evaluated through the following calculation:

$$\frac{FP-OP}{OP} \cdot \frac{OW}{OW-FW} = I$$

FP—Permeability of Core After Treatment.
OP—Permeability of Core Prior to Treatment.
OW—Weight of Core Prior to Treatment.
FW—Weight of Core After Treatment.

The index, based on this calculation, is probably one of the best indications of the adaptability of the formation to acidizing. When the same amount of acid is used on two wells, that well which has the highest acidizing index, should give the greater relative increase in production.

It is interesting to note that the index is a function of two factors, increase in permeability and loss in weight. The increased permeability of a core is a direct measurement of increased rate of flow and the increase is generally caused by removal of pore-blocking materials. However, this factor alone cannot

be used as a measure of the treatability of a formation as it does not take into account the amount of material removed or the amount of acid used in the treatment. By using an index which is a function of both the increase in permeability and the loss in weight, a unit is obtained which does take into account both the increase in flow obtained and the amount of acid used.

The significance of the index naturally depends on the character of the acid treatment; in some cases plain hydrochloric acid will give a satisfactory increase in permeability, but in other cases the acid requires the addition of other substances that will increase the rate of attack and leave less residue in the pores. After the proper type of acid has been selected, determination of the index may proceed as above indicated.

Deep Pumping Wells—E. Boaden, in JOUR. INST. PETROLEUM TECHNOLOGISTS, vol. 24 (1938), No. 172, pp. 112-123.

From Roumanian experience the author argues that in many cases the gas lift stage in the producing life of an oil well may be eliminated by an early installation of pumping equipment. Exceptions of course are cases where large liquid volumes, high gal-oil ratios or sandy conditions or other unusual circumstances are involved. Much also depends on the choice of pumping and power equipment and the care with which pumping operations are supervised. Many useful hints in this direction are given. Only wells deeper than 3,300 ft. are considered.

As regards dealing with the paraffin nuisance in pumping wells the author considers that the best all-round method is to make periodical injections of hot oil into the tubing after lifting the plunger and standing valve. It is found that the quantity needed for efficient washing varies at different wells, but if sufficient is pumped to fill the tubing string, it will probably meet the case. No pump is required, since the oil can be run in from a small lease tank so arranged as to have fall to the well mouth, and in the case of a group of wells a central tank can be arranged to serve the group. The temperature of injected oil is about 100 deg. C. After the injection is finished, the standing valve is lowered into place and pumping resumed. The whole operation takes two to four hours.

Gas Lift, the Modern Method of Oil Production—S. F. Shaw, in OIL AND GAS JOUR., vol. 36 (1938), No. 42, pp. 42-44.

This is an interesting and important discussion of gas lift in which facts and practices in many oilfields throughout the world are discussed. The subject of lifting oil by gas is one that has many differing aspects from the engineering and especially the economic points of view. One of the principal factors is the depth of the well; in this respect it is convenient to classify gas lift operations on the following basis: depths from a few feet to 2,000 ft.; from 2,000 to 4,000 ft., and so on up to 10,000 ft. The operations under each of these depth classifications are then influenced by the flowing pressure, permeability of the sand, character and density of the fluid (oil and water, if present). Gas lift may be used economically under one set of these circumstances and not under another, thus presenting a much varied problem for the petroleum engineer. The instances given in the paper of decisions arrived at in various parts of the world are numerous and instructive.

On the Gulf Coast, wells are being completed at great depths, and so far as is known, there is no method that will artificially lift the oil from these depths except gas-lift, when natural flow ceases. Yet casings are being employed for completing some of these wells that will never permit efficient gas-lift operations, nor will efficient natural flow be possible after the first flush is over.

OIL TRANSPORTATION

Tank-Ship Operation at High Speed—B. Orchard Lisle in U. S. NAVAL INSTITUTE PROCEEDINGS, vol. 64 (1938) No. 420, pp. 211-218 (with 6 photos).

The Japanese have pioneered in the building of high-speed oil tankers, and their example has recently been noted with interest by other naval constructors. Practically all (90 percent) of Japan's supply of petroleum must be imported, and the main sources of supply (California and Netherland East Indies) are far away. Questions of national security as well as commercial considerations have made it necessary for the Japanese to establish this oil traffic on the most efficient basis. There were three options: to build as many tankers of the conventional model as would be required, or fewer big tankers of larger deadweight carrying capacity, or a smaller number of fast tankers of more moderate tonnage. The choice fell on the third method, and the results appear to have justified the proposition both from the standpoint of time saving and operating costs.

According to figures collected by the author, a fast tanker with a net capacity for 12,000 tons of oil making 12.5 annual round trips between Los Angeles and Yokohama will have a total operating cost of $224,156, whereas the total cost of operating an ordinary tanker of equal capacity making 7.5 round trips a year is $149,973. However, the fast tanker will transport 150,000 tons of oil while the ordinary tanker is carrying 90,000 tons. On petroleum alone the faster ship will earn more than the slower one. In addition, the fast tanker in the Japanese service has a source of earnings in a return load of silk which would not be shipped on the slow vessel on account of the higher insurance rate. Both ships may carry return loads of special vegetable oils, and here again the fast tanker will earn more. The general result is that the annual earnings of the high-speed tanker over those of the normal speed vessel will amount to more than $880,000.

Combined Tanker-Freighter "Dolomite II"—MOTORSHIP AND DIESEL BOATING, February, 1938.

This unconventional vessel is the converted steamship MAYTHAM, which was stripped to the bare hull, deck structures removed, and machinery taken out before rebuilding the ship in its new form. Electric welding was used exclusively in the reconstruction and in every way the re-named craft is a modern and efficient unit. It is 297 ft. long by 41 ft. broad and has a deadweight capacity of 3,400 tons. Its cargo oil capacity is approximately 24,000 bbl. The speed is about 14 knots.

Although primarily intended for coastwise service either as a tanker or general cargo carrier, the vessel is also adapted for canal operation. To this end the upper pilot house on the admidships deckhouse, which is streamlined, is mounted on six motor-driven screws, whereby it can be retracted into a well in the amidships hold when the Barge Canal is being navigated. Crew's quarters are around the engine room casing and here again when the vessel is used for canal operation this deckhouse is removed, as is the funnel and masts, and the lifeboats are stowed on the main deck, while the davits are hinged down. The accommodation for the officers and crew around the engine casing is made lighter by making the trunk of glass where it passes through the accommodation.

The poop and amidships deckhouse is connected by a cat-walk; underneath this is a square-section duct-keel-like structure of welded steel plate, through which all steam and water pipes, electric cables, etc., pass towards the amidships and forward parts of the vessel. This duct is packed with granulated cork to prevent steam condensation and freezing of water in cold weather.

The new propelling machinery comprises two four-stroke cycle Diesel engines of the trunk-piston type. Each is rated at 720 b.h.p. at 600 r.p.m. and drives its propeller shaft through a reduction gear giving a propeller speed of 300 r.p.m. The engines are of the directly-reversible airless-injection type and their exhausts are passed through a Scotch boiler located in an elevated position between the propeller shafts at the after end of the engine room. The boiler is also provided with oil-burning equipment and may be operated either as a composite unit or as an alternately-fired boiler.

The three cargo oil pumps are turbo-driven units, two of 1,000 gal. per min. capacity and one of 1,300 per min. output.

This novel general cargo-tanker converted ship has proved most successful and has entered upon a three-fold type of charter for nine years, by which it will carry phosphate to Florida, molasses from Cuba to New Orleans, and oil from Gulf ports to New York. Further vessels are to be built by the Dolomite Marine Corporation.

Experiments on Pipe Coatings—Charles Fitzgerald and M. G. Johnson, in IND. ENG. CHEM., vol. 30 (1938) No. 3, pp. 294-296.

From among the coating materials tested at Spindle Top Gully there has emerged one shield of some promise—celluloid or cellulose nitrate plastic. On the original test the celluloid was applied in two spiral wraps five-thousandths of an inch thick and bonded to the pipe with an adhesive. After three years in a highly corrosive soil that subjects a coating to extreme stresses, the results were so satisfactory that this material is used in pipeline repair work. The method is as follows:

COATING. One application of No-Ox-Id "A" Special applied by hand on pipe that has been cleaned, as well as possible, with hand scrapers and gasoline. The only variation is that No-Ox-Id "A" grade is used during midsummer instead of "A" Special because it has a heavier body and thereby provides a heavier coating.

Celluloid pipe coating three years in a corrosive soil.

Coating a pipe line with the celluloid film.

SHIELD. One spiral lapped wrap of 0.010-in. thick black stock Pyralin 8.5 in. wide, over smooth pipe surface, half-soles and whole soles with a lap of about one inch. The same material is softened in a solution for application over collars, girth welds, and ends of half or whole soles.

In locations where the line may be buried very deep, or across creeks and rivers where it may be inaccessible during flood periods, two wraps of Pyralin are used. The second layer is wrapped spirally directly over the first without an intermediate coating and in such a manner that the center of the sheet on the second wrap is at the lap of the first wrap.

Another coating with some promise but as yet in an early experimental stage is pure rubber.

The rubber coating has the particular advantage over more rigid shields in that the wrapping angle may be altered at will, as it is very pliable and will stretch. Obstacles such as pit welds, ends or edges of half-soles, and girth welds present no wrapping difficulty; the spiral may be continued over them without bulging or tearing. Contrary to expectations, it is not easily punctured by rocks or clods.

No cost data are given.

REFINING

Commercial Acid Treating Reproduced in the Laboratory—F. Sager, in REFINER, vol. 17 (1938), No. 2, pp. 57-61.

An account is given of a new continuous laboratory apparatus for determining optimal plant conditions for single or double stage acid refining of light hydrocarbon oils. Heretofore it has been considered that no single-stage laboratory treatment will duplicate the functioning of a multi-stage commercial plant; for predicting results in practice single-stage laboratory experiments have been made and interpreted by the help of correlation curves based on accumulated knowledge.

The outfit here described is a small unit which allows of the following operations: single-stage treating with centrifugal separation; single-stage treating with gravity separation; two-stage counter-current treatment with gravity settling in the first (spent acid) stage and centrifugal separation in the second (fresh acid) stage; two-stage counter-current treatment with centrifugal separation in each stage.

The outfit has been installed in a Burma refinery which is operating the Separator-Novel (S-N) treating process for cracked distillates and similar products, where it gives the required information with a minimum of time and expense. Acid-treating losses can be exactly determined.

Modern Fractionating of Mineral Oils by Means of Light Hydrocarbons—Marian Godlewicz in PETROLEUM, vol. 34 (1938), No. 8, pp. 1-5.

There are now three general methods of fractionating minerals oils, which may be summarily described as follows: (1) fractionating at constant temperature below the critical temperature of the solvent by altering the quantity of the light hydrocarbon in use; (2) by altering the temperature just below the critical temperature; and (3) by altering the pressure while the solvent is kept heated above the critical temperature.

The general characteristic of the processes which operate under pressure is that the composition and the density of the solvent (whether single, as propane, or mixed, as propane plus ethane or methane) are changed by changing the pressure, and hence its solvent power on heavy hydrocarbons is also changed. This holds for the second and third of the above-named methods, but not in every case with the first method, as when propane is mixed with methane.

However, it is now known that fractionating effects can also be obtained by saturating a propane solution with a gas other than methane, as CO_2 at 20 deg. C., for example, because a mixture of propane and CO_2 has a lower critical temperature than pure propane.

At the present time practical refiners of lubricating oils are not particularly interested in doing more than get rid of asphalts and coloring matters, for which purposes fractionating with the light hydrocarbons is convenient and accurate. With present knowledge of the behaviors of these hydrocarbons in the neighborhood of their critical points it seems possible to go a step further and divide an ordinary refined lubricating oil into narrower fractions, if it should prove to be true that products of greater value may thereby be obtained.

In any case, it is interesting to note the relative pressures required for fractionation by the light solvents. For separating coloring matters, propane saturated at room temperature with CO_2 requires a pressure of 25 to 30 atmos.; propane saturated with methane 40 to 50 atmos., butane saturated with methane about 80 atmos.; propane alone under the critical temperature (75 deg. to 85 deg. C.) requires 25 to 35 atmos., propane-butane above the critical temperature (160 deg. C) more than 60 atmos.

From this it may be seen that the lowest pressure, and consequently the least expensive plant, are required in the process employing propane saturated with CO_2, and the process employing propane just under the critical temperature.

CHEMISTRY

Importance of Polymerization Phenomena for Resin Formation in Motor Fuels—Georg R. Schultze, in OEL UND KOHLE, vol. 14 (1938), No. 6, pp. 113-117.

The phenomena that lead to the formation of gums in cracked gasoline are extraordinarily complex, and in spite of all the research spent on it the problem is still far from being cleared up, although air, light, heat, metallic catalysis and length of time in storage have been recognized as affecting the keeping quality of the gasoline. Some 20 different methods have been proposed for determining gum content. It is also clear that peroxides (resulting from exposure to air) play a part in gum formation, but gum formation also occurs in the absence of air; from this latter circumstance it is evident that gum formation is by nature a polymerization process.

Among substances found in cracked gasoline that are most apt to undergo polymerization are dienes, such as cyclopentadiene and dicyclopentadiene. The author made a research in which he found that cyclopentadiene is reversibly polymerized to dicyclopentadiene; the latter, on exposure to heat further polymerizes to gum-like substances.

The bearing of the facts learned in this investigation on methods of testing the gumming proclivities of cracked gasoline is summarized as follows: the gasoline in its fresh condition contains polymerizable dienes. The copper dish test, glass dish test, air jet test, and the flash evaporation test detect only the higher boiling dienes such as dicyclopentadiene; these tests do not detect the more volatile cyclopentadiene which has not yet been polymerized into its dimer. Hence these tests indicate only the actual gum content, and throw no light on the potential gum content.

The surest way to obtain definite information is to heat the gasoline with oxygen in a closed vessel under pressure at an elevated temperature. This treatment insures the polymerization of all dienes present, which can then be quantitatively determined by the copper dish method. By making the dish test before and after the oxygen pressure test some conclusions can be drawn as to the relative amounts of low boiling and high boiling dienes in the gasoline.

Iodine Number of Gasolines—B. Garre and H. Grosse, in OEL UND KOHLE, vol. 14 (1938), No. 5, pp. 94-95.

The authors find that the Kaufmann method for determining the iodine number of fatty acids by sodium bromide-bromide in methyl alcohol solution is very well adapted for similar tests on gasolines. The end point is sharp and side reactions (substitutions) are reduced to a minimum. This is in contrast with the Hanus method. The Kaufmann titration fluid is prepared from a fifth-normal bromine solution of bromine in methyl alcohol saturated with sodium bromide, which is suitably diluted with chloroform.

Direct Oxidation of Oils by the Air; Formation of Peroxides—P. Mondain-Monval and S. Marteau in ANNES OFFICE COMBUSTIBLES LIQUIDES, 1937, pp. 923-928.

Oils were heated in a tube through which a current of air heated to various temperatures was passed; any distillate which passed over was collected in a cooled flask. The oils experimented on included paraffin, vaseline, various kinds of lubricating oil, castor oil, olive oil, colza oil, peanut oil, neat's foot oil and cod liver oil.

The temperature at which oxidation began varied between 150 deg. and 225 deg. C., depending on the nature of the oil, and the rates of oxidation accelerated up to temperatures between 180 deg. and 300 deg. The distillates separated into two layers, the upper layer consisting mostly of the original oil contaminated by various oxidation products, while the lower aqueous layer contained notable amounts of peroxides as shown by the alkaline potash iodide test.

The mineral oils richest in components of high molecular weight, such as paraffin, vaseline and heavy lubricating oils are oxidized at relatively low temperatures, whereas the vegetable oils began to oxidize at relatively higher temperatures.

The main point of this research is that it requires only a small elevation of temperature to bring about oxidation of mineral oils in the air, with formation of oxyalkylperoxides. The presence of these peroxides in the oxidized oil may satisfactorily explain the occasional explosions that take place in air compressors.

Olefins and Conjugated Dienes from Gas Oil—Hans Tropsch, Charles L. Thomas, Gustav Egloff and J. C. Morrell, in IND. ENG. CHEM., vol. 30 (1938), No. 2, pp. 169-172.

That small amounts of butadiene are formed in the pyrolysis of various hydrocarbons and other organic compounds is well known. Higher diolefins are formed in certain cracking operations using petroleum fractions as the charging stocks. Although conjugated dienes have been shown to be present in the reaction products of a large number of thermal reactions, the conditions favorable to the formation of such compounds and the maximum yields have not been determined. Because of their value in organic syntheses it is desirable to determine the maximum yields of these compounds as well as of the other olefins of actual and potential value which are produced simultaneously.

The authors studied the problem experimentally and found that gas-oil can be made to yield useful

products corresponding to 73 weight percent of the charge (83 weight percent of the reacted gas-oil) by pyrolysis at 950 deg. C. and 175 mm. pressure with a contact time of 0.05 sec. The weight percent yields of products interesting for chemical synthesis are: ethylene, 28.2 percent; propene, 19.7 percent; butadiene, 6.6 percent; butenes, 8.3 percent; pentadiene, 3.1 percent, and higher conjugated dienes, 7.2 percent based on the gas-oil reacted. In addition, 10.8 percent of a high antiknock gasoline is produced.

Under the conditions studied the butadiene yield is not greatly influenced by temperature (800 deg. to 1000 deg. C.) or pressure (50 to 500 mm.), provided the oil is gasified to the extent of 50 to 75 percent of the charge.

Hydration of Propylene Under Pressure—Frank J. Majewski and L. F. Marek, in IND. ENG. CHEM., vol. 30 (1938) No. 2, pp. 203-210.

Developments in petroleum technology to produce high antiknock fuels have left refineries overburdened with large quantities of gas of high olefin content. When it is realized that slightly less than 2,000,000 bbl. of oil are cracked daily to produce in excess of 1,000,000,000 cu. ft. of gas containing from 1 to 23 percent ethylene and 5 to 18 percent propylene the importance of refinery gas utilization is more appreciated. To date, considerable research has been done in this direction; much of it has been successfully culminated into industrial processes with which we are all familiar. In the present case attention has been focused on the utilization of propylene.

Isopropanol of high strength was produced by the direct high-pressure hydration of propylene gas with water in the presence of dilute phosphoric acid catalyst. The investigation was studied over a range of 95 to 503 atmos. pressure and of 160 deg. to 290 deg. C. The equilibrium was determined over this range of conditions, and the following free-energy equations were obtained for the formation of alcohol:

liquid phase $dF° = 23.25\ T°_c. - 3005$
vapor phase $dF° = 34.7\ T°_c. - 2530$

Under favorable conditions of operation, liquid-phase concentrations may reach 200 grams of isopropanol per liter of alcohol solution, and vapor-phase concentrations as high as 700 gr. per liter of condensate. The concentrations of alcohol formed in both liquid and vapor phases increased as the pressure increased and the temperature decreased. The rate of reaction was very rapid at temperatures above 240 deg. C. Of the two possible alcohols, only the iso compound was present. In addition to isopropanol, isopropyl ether and polymer were formed as byproducts at the higher temperatures and pressures. The boiling range of the polymer changed markedly as the pressure, temperature, and reaction time increased.

Preparation of Naphthenesulphonic Acids—S. von Pilat and N. Turkiewicz in PETROLEUM, vol. 34 (1938), No. 8, pp. 5-8.

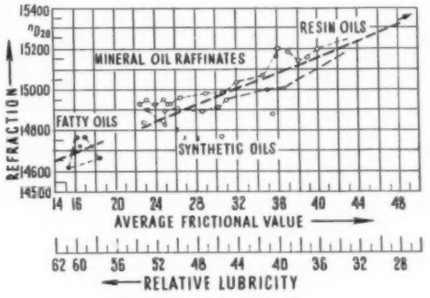
Starting from naphthenic acids separated from petroleum distillates it has been found, for the first time, possible to prepare naphthenesulphonic acids analogous to the naphthene-carbonylic acids. These naphthenesulphonic acids are strong acids which, in contrast with the naphthenic acids, are easily soluble in water and form colorless, crystalline sodium, calcium, barium and silver salts. The solutions strongly depress the surface tension of water and have great foaming power. The differences in the solubilities of the salts make it possible to separate the naphthenesulphonic acids from the aliphatic sulphonic acids which are formed from the fatty acids accompanying the naphthenic acids.

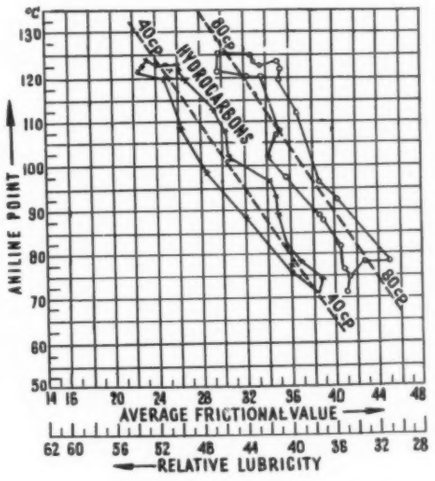
PHYSICS

New Results of Lubricity Investigations with the Thoma Oil Testing Machine—E. H. Kadmer in OEL UND KOHLE, vol. 14 (1938), No. 8, pp. 147-151.

The author states that, for the first time in the history of the science of lubrication, it has been possible to demonstrate the differences in the lubricating properties of refined mineral oils, and to connect these properties definitely with known physical properties of the oil.

These relations have been demonstrated by new work with the Thoma oil tester. In this machine (originated at the Hydraulic Institute of the Munich Technical High School) two revolving rollers of steel or other material are crossed at right angles in a bath of the oil at known temperatures, which are chosen so as to coincide with one of two standard viscosities (80 or 40 centipoises). The two rollers, one of which rests upon the other, are rotated at different speeds (50 and 300 r.p.m.). The friction between the two rollers is a purely sliding friction which can be varied by applying weight on the upper roller; the resulting frictional loss is registered by means of a torsion balance.





The principal object of the present investigation was to see whether differences between the lubricities of mineral oil raffinates could be clearly demonstrated. The results show not only are these differences clearly visible, but that they also seem to stand in close connection with the chemical structure of the hydrocarbons. The average friction value rises proportionally with the density, the velocity slope (pole height), refraction, aniline point and the percentage of C-rings in the oil molecules. It further clearly appears that all fatty oils, especially all fatty acids, have much lower frictional values than mineral oils, while mineral oils rich in aromatics, especially refined resin oil, show high frictional values.

The connection between refraction and the aniline points of lubricants on the one hand and lubricity as demonstrated by the Thoma oil testing machine on the other hand, are illustrated by means of the accompanying graphs. The upper graph shows relative lubricity plotted against refraction. The relation is practically linear, passing from the fatty oils at the lower left through the mineral oil raffinates to the resin oils at the upper right. These values are obtained with the viscosity of the lubricants adjusted to 40 centipoises. The lower graph shows the relation between relative lubricity and aniline point of hydrocarbons at 40 and 80 centipoises. Here the linear relationships at the two viscosities are again unmistakably evident. Similar unmistakable relations are pointed out for gravity and proportion of C-rings to C-chains.

Studies on Viscosimetry—A. Bondi, in PETROLEUM, vol. 34 (1938), No. 6, pp. 1-8.

This paper considers especially the application of the microviscosimeter devised by H. Levine (IND. ENG. CHEM., ANALYT. ED. vol. 6, p. 147) in exploring the relations between viscosity and temperature (viscosity pole-height), and reaches mostly negative conclusions. It is found that even with unrefined oils the viscosity pole-height gives no clear-cut indication of the source of the oil, because quite irregular values are obtained with different fractions of the distillates.

It is also found that the magnitude of the viscosity pole-height has no direct relation to the other characteristics of the oil, but is a function of the space lattice of the individual particles of liquid. Consequently there is no general valid relation between the viscosity pole-height and any other characteristic of the temperature-viscosity relation, such as density, molecular volume or refraction.

However, some possibilities of calulating the viscosities of mixtures and the lubricating capacities of components that it is proposed to mix are pointed out. The question of whether viscosity pole-height is an additive property was especially examined. Theoretically this should be the case, but it is not strictly so; for practical purposes there is a sufficiently close additivity within the range of 1.8 to 4.5 so far as only mixtures of hydrocarbons (without addition of fatty acids) are concerned.

ECONOMICS

Oil Reserves are Falling Behind Consumption—W. V. Howard in OIL & GAS JOUR., vol. 36 (1938) No. 39, pp. 12-14.

The author analyzes current data on petroleum reserves and reaches the conclusion that reserves must increase rapidly in order to keep pace with future demands.

Based on the increase in production in 1937 over 1936, there was a deficiency in new reserves discovered of 898,676,994 bbl. if the years' supply of oil in reserve is to be maintained at the level of January 1st, 1937.

In spite of the fact that on January 1st, 1935, reserves amounted to 13.5 years' supply, and reserves of 4,726,014,000 bbl. have been discovered during the past three years, reserves now amount to only 10.7 years' supply at the 1937 rate of production. If 11 years' supply is considered the desirable reserve, there was a deficiency in newly discovered reserves of 477,626,656 bbl. during the three-year period.

It is probable that some of this apparent deficiency can be made up by a revision of reserves in older fields, particularly of the stripper type.

If production during 1938 is placed at five to 10 percent greater than in 1937, new reserves of between 2,500,000,000 and 3,000,000,000 bbl. must be discovered during 1938.

World Consumption of Petroleum and Related Products for Military Purposes in 1937

	Motor fuel	Gas and fuel oils	Lubricants	Total
		In barrels		
British Empire	1,637,000	10,526,000	81,800	12,244,800
United States	1,188,000	9,210,000	61,800	10,459,800
Japan	1,077,000	6,200,000	51,800	7,328,000
France	1,578,000	4,600,000	64,000	6,242,000
Italy	1,559,000	3,465,000	60,000	5,084,000
Russia	1,575,000	1,498,000	55,000	3,128,000
Germany	1,403,000	1,000,000	47,600	2,450,600
Spain	482,000	742,000	17,600	1,241,600
Argentina	58,700	742,000	3,900	804,600
Sweden	115,700	630,000	4,700	750,400
Netherlands (a)	.....	660,000	1,900	661,900
Chile	62,000	500,000	3,400	565,400
China	75,400	400,000	3,500	478,900
Brazil	32,900	439,000	2,200	474,100
Turkey	138,900	320,000	5,300	464,200
Roumania	345,500	.....	10,800	356,300
Greece	57,000	275,000	2,500	334,500
Norway	.....	300,000	900	300,900
Poland	219,000	.....	6,600	225,600
Portugal	17,200	200,000	1,100	218,300
Denmark	25,000	120,000	1,100	146,100
Finland	5,400	116,000	500	121,900
Cuba	.....	116,000	300	116,300
Belgium	83,500	.....	2,700	86,200
Czechoslovakia	26,900	.....	800	27,700
Yugoslavia	26,900	.....	800	27,700
Austria	10,700	.....	300	11,000
Hungary	10,700	.....	300	11,000
Mexico	10,700	.....	300	11,000
Bulgaria	5,400	.....	200	5,600
Others	315,000 (b)	3,240,000	11,400	3,566,400
Total	12,141,500	45,299,000	505,100	57,945,600

(a) Includes Netherlands East Indies
(b) Includes 2,240,000 bbl. of fuel oil consumed by the armies of countries shown in this table and on which no segregation by countries was attempted. In addition, about 70,000 bbl. of miscellaneous products were consumed for military purposes during 1937.

World Consumption of Petroleum Products for Military Purposes—V. R. Garfias, R. V. Whetsel and J. W. Ristori, before AM. INST. MIN. & MET. ENGINEERS, New York meeting, February, 1938.

There is no reliable data available either on the storage capacity and, therefore, oil stocks, or on the petroleum consumption for military purposes in foreign countries. This information is so closely related to national defence that its divulgation is forbidden. One can, therefore, but surmise as to these facilities and needs in line with the relative strength of the military land, air and sea forces of the various countries.

Making use of such sources of information as are available the authors present the accompanying table as a fair approximation to the facts.

Oil and the Mediterranean Highway—Oskar Tokayer, in PETROLEUM PRESS SERVICE, vol. 5 (1938), No. 2, pp. 13-16.

High British naval authorities have argued that maintenance of the Mediterranean lifeline is an indispensable condition for assuring the British oil supply and for the security of the Empire. A somewhat different view may be taken when the normal oil traffic of the Mediterranean and the alternative routes are considered.

Geographically, the producing countries which furnish the chief European nations with their oil can be divided into three principle groups. The first group, and the most important as regards both total output and exports, is that comprising the U.S.A., Venezuela, Mexico, Colombia and Trinidad. The second group consists of Iraq, Russia and Roumania, most of whose exports travel through the Mediterranean. The third includes Iran, the Dutch East Indies and British Borneo, all of which have a natural outlet to the Indian Ocean.

Examination of the statistics shows that 14.4 percent of England's oil requirements come from the Black Sea and Mediterranean ports and 18.7 per cent through the Suez Canal; the rest, 66.9 percent, comes from the United States, Central and South America and other sources. More than half of Britain's Mediterranean supplies come from Iran, and this could be diverted via the Cape. As regards the rest of the Mediterranean supply (from Iraq), this could also be routed around the Cape via Suez, provided the British retain command of the eastern Mediterranean shore. A rupture of the Mediterranean line would therefore at most mean a degree of inconvenience due to longer routes and the need of more tankships. Although France now depends greatly on Iraq oil, which might be cut off by a hostile Italy, the French would only need to increase their imports from across the Atlantic. On the other hand, in case of war Italy might be cut off from every source of oil except Roumania, and even Roumanian oil would have to be transported partly overland.

Fuels of Tomorrow—JOUR. AMER. SOC. NAVAL ENGRS., No. 4, November, 1937.

Appraisal of present trends and future probabilities indicates that:

(1) Coal will continue to be the principal fuel used for generation of public utility and major industrial power. Technologic improvements and new hydroelectric power will tend to reduce consumption of coal. Increasing demand for energy and a decreasing supply of cheap residual oil will increase the coal consumed for power purposes. No material change is expected in the near future, but in 10 or 15 years the trend will favor increased consumption of coal.

Proved Oil Reserves of the United States Placed at 15,500,000,000 bbl.—Committee Report, AM. PETROLEUM INSTITUTE.

Figured as of January 1st, 1938, the proven reserves of the United States amounted to 15,500,000,000 bbl. This estimate is fully 2,500,000,000 bbl. more than the estimate as of January 1st, 1937; the increase is due partly to new reserves discovered in 1937, but chiefly to upward revisions of the 1937 estimates based not only on better knowledge of the potentialities of existing fields, but also to improvements in the technology of removing the oil from the ground. This is the natural result of improved efficiency and true conservation which avoids waste, utilizes the natural water drive and the lifting force of gas. In short, the present tendency is to leave less unrecoverable oil in the formation when wells are abandoned; hence a reserve that may appear small under wasteful and inefficient operation may be more than doubled by careful exploitation.

	Reserves As of January 1, 1937	Revisions in Reserves in Fields Included in Column 1	New Reserves Discovered During 1937	Total (Columns 1 +2 +3)	Production During 1937	Reserves As of January 1, 1938
	(1)	(2)	(3)	(4)	(5)	(6)
			(All Figures In Thousands of Barrels)			
California	2,955,726	295,000	51,000	3,301,726	238,584	3,063,142
Rocky Mountain States:						
Wyoming	238,980	20,625	25,050	284,655	18,733	265,922
Montana	91,810	23,400	.....	115,210	5,832	109,378
Colorado	15,222	3,400	2,000	20,622	1,497	19,125
New Mexico	5,793	.....	.....	5,793	379	5,414
Total	351,805	47,425	27,050	426,280	26,441	399,839
Central and Southern States:						
New Mexico (S. E.)	464,889	110,343	4,320	579,552	38,379	541,173
Texas	6,421,800	1,921,314	416,000	8,759,114	511,186	8,247,928
Oklahoma	1,141,000	242,464	57,228	1,440,692	228,440	1,212,252
Kansas	568,271	21,729	82,000	672,000	70,683	601,317
Arkansas	84,185	3,308	116,401	203,894	11,793	192,101
Louisiana	524,052	132,792	147,243	804,087	90,653	713,434
Total	9,204,197	2,431,950	823,192	12,459,339	951,134	11,508,205
Eastern States:						
Illinois	28,210	.....	20,000	48,210	7,326	40,884
Indiana	3,441	.....	.....	3,441	819	2,622
Kentucky	38,846	.....	5,000	43,846	5,480	38,366
Michigan	44,199	18,415	2,500	65,114	15,933	49,181
New York	66,000	.....	.....	66,000	5,465	60,535
Ohio	32,000	.....	.....	32,000	3,544	28,456
Pennsylvania	307,000	.....	.....	307,000	19,114	287,886
West Virginia	31,976	.....	.....	31,976	3,824	28,152
Total	551,672	18,415	27,500	597,587	61,505	536,082
Total United States	13,063,400	2,792,790	928,742	16,784,932	1,277,664	15,507,268

(2) No substitute has appeared for metallurgical coke. The coke-oven industry will expand and consume more coal in accordance with metallurgical needs.

(3) Convenience and uniformity of automatic heating of homes with gas or oil will continue to attract more users, even at higher costs than those prevailing today. Stoker-fired domestic furnaces eventually will give automatic service at a lower cost than for oil or gas, and high- and low-temperature cokes will supplement anthracite as solid smokeless fuel.

(4) In 1929, 88 percent of the railroad fuel was coal. Since then Diesel locomotives have been adopted by several railroads for light-weight high-speed passenger trains and an increase in Diesels for such service is expected, but no general change in freight haulage from steam to Diesel power is likely to take place.

(5) Marine transportation is energized by oil. Approximately three-fourths of the marine fuel used in 1936 was oil, and 40 percent of this oil was used in Diesel engines. This trend will continue.

(6) From the very beginning of the automobile industry recurring threats of shortage of gasoline were met by finding new pools and improving production technique, and in the refinery, by increasing yields and making a more efficient product. The end has not been reached. We are just beginning to use scientific methods in extracting oil from the sands. Catalytic polymerization and hydrogenation eventually will furnish the means for complete conversion of volatile liquids and heavy petroleum to gasoline.

The accompanying table gives particulars regarding the various areas and districts. It will be observed that more than half (8,247,928,000 bbl.) of the estimated reserves are in Texas; California is second with 3,063,142,000 bbl. and Oklahoma third with 1,141,000,000 bbl.; these three States therefore hold five-sixths of all the oil reserves of the U. S. A.

These estimates were prepared in collaboration with more than 100 petroleum geologists and engineers, and undoubtedly reflect the most dependable present knowledge. At the same time it is interesting to note that no longer ago than 1925 the A.P.I. estimate of future production from proven acreage was only 5,300,000,000 bbl. and that every estimate since then has been exceeded by proven increases.

The estimates here given represent only petroleum that may be extracted by current methods of production from (a) fields completely developed or drilled up, and (b) fields not completely developed but sufficiently drilled and explored to allow of making a reasonably accurate estimate of reserves.

Discovery Rates in Oil Finding—F. F. Campbell, in BULL. AM. ASSOC. PETROLEUM GEOLOGISTS, vol. 22 (1938) No. 1, pp. 109-110.

Commenting on the statement by Pratt (IBID. vol. 21, p. 697) that the declining rate of oil discovery since 1930 has been largely due to "the inadequacy of our finding technique to cope with the increased difficulty of oil finding," the author agrees that the oil discovered per dry hole did decline from 270,000 bbl. for the period 1926-30 to 208,000 bbl.

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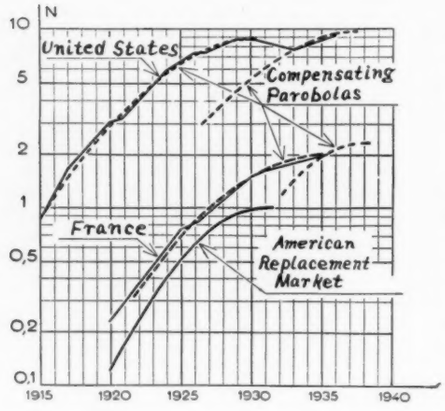
per dry hole for the period 1931-35. But if this decline were the major factor in the lower rate of discovery, there should have been a more nearly equal amount of prospecting effort in each of these periods. Actually, the effectiveness of the prospecting effort declined 23 percent as measured by the oil discovered per dry hole, whereas the volume of effort as measured by the dry hole index declined 46.5 percent. Although less effective effort was a contributing factor, the major factor was a smaller volume of effort.

It follows that until and unless there is a more drastic decline in the adequacy of oil-finding technique to cope with the problem of finding oil, the more effort there is expended, the more oil there will be found, and that, in the industry as a whole, volume of effort is related to price.

By applying this economic analysis to the current situation, it is seen that the price of oil was depressed during 1931-35 by the pressure of reserves found in the preceding period. A large part of these reserves were in East Texas and were immediately available for the market. The number of dry holes drilled during 1931-35 dropped in response to the lower price, and so the rate of discovery declined. It may be predicted for the period 1935-40, that under the stimulus of a rising price, more dry holes will be drilled, more oil wells will be found, and the discovery rate will again go up. But in order to make this prediction come true, the geologist will have to succeed in discovering as much oil per dry hole drilled as he has in the past. This is the increasingly difficult task which confronts geologists.

New Light on Markets for Automotive Vehicles—J. Andreau in BULL. ASSOC. FRANCAISE DES TECHNICIENS DU PETROLE, No. 41 (Jan. 1938), pp. 97-115.

The author has compared the development of the market for automobiles in the United States and France. When the statistical data of the two markets are reduced to a common basis the result is the group of curves shown in the accompanying diagram. This diagram represents the number of automotive vehicles in use in the United States and in France for each 40,000,000 inhabitants during the period 1915-1936. In both cases the number of vehicles on the road is seen to increase rapidly at first, then less and less rapidly; in the United States a ceiling was reached in 1930, in France by 1936.



In the diagram the ordinates are proportional to the number of cars, the abscissas are time in years. In general the progress of the American market may be represented by the parabolic equation:

$$\log N = 0.4771 + 0.09024\ t - 0.004835\ t^2$$

Wherein N is the number of vehicles. A similar equation holds for the French automobile market. When the curves of the two equations are translated to comparable positions on the diagram the homology of the two markets becomes clearly evident. This means that the economic laws governing the American and the French markets are practically superposable and stem from the same phenomena.

The point here is that in spite of the fact that automobiles cost more in France than in the U.S. and hence the ratio of cars to population is smaller, in both cases the market begins in a state of unsaturation and moves toward the saturation point according to the same fundamental law. By noting the characteristics of the curve of growth in the early years it would have been possible to calculate in both cases when the ceiling or saturation point would be reached.

It is interesting to note that the equation above given is of the same form as the logistic equation which has been found to apply to a great many—in fact to all—natural growth processes, as for instance the rate at which a young animal increases in weight or the rate at which the population of the United States has increased. By applying the same principle to markets, especially to unsaturated markets, it should be possible to make fairly accurate predictions, provided that ample and accurate statistics are available.

BOOKS

A Short History of Naval and Marine Engineering, by Edgar C. Smith; published 1937 by CAMBRIDGE UNIVERSITY PRESS, England; 376 pages.

In 22 chapters, an engineer-captain in the Royal Navy starts with the birth of the steamboat and relates the story of steam navigation through its pioneer stages to its present marvelous development. It is an interesting and in many parts dramatic story, suitable for general reading because it is not technical.

Several chapters touch on the use of petroleum products in modern maritime propulsion, and the history of marine internal combustion engine is reviewed. Here is a book both entertaining and instructive which deserves many readers, even among persons who have no connection with ships or machinery.

Procedure Handbook of Arc Welding Design and Practice, fifth edition, published 1938 by LINCOLN ELECTRIC CO., Cleveland, Ohio, 1,012 pages, 1,243 illustrations including photographs and drawings; $1.50 U. S., $2.00 foreign.

Here is an encyclopedic work that tells nearly everything about the art of electric welding, including the design of objects to be welded. The title page names no one as author or compiler but the prefaces list more than 100 steel companies, foundries, railroad companies, oil companies, sheet metal works, engineering firms, the U. S. Navy, and other important metal-working concerns or establishments whose technical staffs have contributed material and ideas bearing on an infinite variety of welding problems and accomplishments. With such an enormous supply of shop experience to draw on it is hardly surprising that the book succeeds in filling the traditional long-felt want. Originally published in 1933, a new edition has been needed every year since.

The body of the book comprises eight sections: welding methods and equipment; technique of welding; procedures, speeds and costs of welding mild steel; structure and properties of weld metal; weldability of metals; design for arc welded steel construction of machinery; design for arc welded structures; and typical applications of arc welding in manufacturing, construction and maintenance. In this last section are included examples of welding work in oil refinery equipment, pipe lines and oil production equipment.

Asphalt and Allied Substances, by Herbert Abraham; fourth edition, published 1938 by D. VAN NOSTRAND CO., New York; 1,491 pages.

This large work is offered in a new edition—the first since 1929—to all those engaged in the fabrication, merchandising and application of bituminous products. The readers whom the author is addressing include not only the works chemist engaged in testing and analyzing raw and manufactured products, the refinery or factory superintendent who wishes assistance in blending and compounding mixtures, but also "the ambitious salesman who wants to enlarge his knowledge concerning the scope of the articles he vends." The author's further object is to state the principles underlying the practical application of bituminous products for structural purposes that are of interest to the engineer, contractor and architect.

All these various purposes are carried out on a comprehensive scale. A historical review occupies 50 pages, and the other important divisions are served in proportion. It is superfluous for a reviewer even to list the subjects covered. There seems to be hardly anything relating to asphalt that has been overlooked. The throughness with which the author has covered the field is indicated by the more than 12,000 references to patents and the general literature; and as for books dealing with asphalt and bitumen, more than 900 have been listed. What the author has omitted from his book (if anything) can surely be found in the publications he has cited. Perhaps it should be added that the author does not venture far into the engineering aspects of road construction.

Properties of Typical Crude Oils from Fields of the Eastern Hemisphere—A. J. Kraemer and E. C. Lane, in Bulletin 401, Bureau of Mines; price $0.20.

In this 169-page publication the authors present a great amount of information which offers a means for judging the relative values of the foreign crude oils compared with familiar crude oils of the United States that have been analyzed by Bureau of Mines method. It includes comments, tabulated data, and individual analyses of 142 samples of crude petroleum obtained from Albania, Roumania, Yugoslavia, Greece, Russia, Iran, Iraq, India, Japan, East Indies, New Zealand, Algeria, Egypt and Angola. A bibliography lists all publications of the Bureau of Mines that deal primarily with analyses of crude petroleum and contains references to methods of the American Society for Testing Materials that are used in the Bureau of Mines Hempel method of crude petroleum analysis.

Petroleum Technology, published quarterly by AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS, New York; $4.00 per annum.

For effecting initial prompt distribution of the technical publications (T. P.'s) sponsored by its petroleum division, the A. I. M. M. E. has decided to issue this quarterly. Papers that go into the annual transactions of the Institute will be selected chiefly from the papers that appear in this journal.

The editors are A. B. Parsons, E. J. Kennedy, Jr., E. H. Robie and K. S. Lovell. The first issue is is dated February, 1938, and contains six papers by specialists in various branches.

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(Continued from page 64)

marine craft. These are apparently all destined for service from Vladivostok. The smallest tanker, of 700 tons gross, was supplied by the Namara yard of Osaka, while the other six were standardized vessels built by Mitsubishi at Yokohama.

The Mitsubishi-built tankers are of centerline-bulkhead type, with summer tanks on either side of the expansion trunk. Total oil capacity is 13,272 bbl. Propulsion is by 800 b.h.p. Diesels which, in the case of the YAKAGIR, developed 873 b.h.p. at 225 r.p.m. with trial speed of 12.03 knots.

The vessels are classified according to Lloyd's highest rating, and have been designed for service in ice-bound waters. They each have a straight raked stem and cruiser stern, while the ice-breaker bow is reinforced and constructed at an angle of 32 deg. to the keel. Plating along the load line is heavy to withstand buffeting by cake ice. Particulars of this class are: length, 238 ft.; moulded beam, 36 ft.; moulded depth, 20 ft. 6 in.; deadweight, 1,800 to 2,200 tons; and gross register, 1,435 tons. Each vessel carries on its upper deck a tank launch; speed, eight knots; capacity, 63 bbl.

In order to meet Soviet regulations, accommodations are of unusually spacious nature—both single and double cabins are provided for officers and crew.

In order to build up a fleet capable of handling oil exports the Soviet Government originally chartered and purchased tankers, and during the First Piatiletka commenced building bulk oil carriers in domestic yards. During this period considerable efforts were made to rehabilitate sunken, damaged and obsolete ships.

After nationalization of shipping, the State Mercantile Fleet (Sovtorgflot) was created, existing first as several separate shipping agencies: Northern, Baltic, Black Sea, Azov Sea, and Caspian Sea Agencies. The Caspian was absorbed by the oil industry in the latter part of 1923, since 90 percent of its work was oil transport. By 1925 the fleet included 81 motor-driven tank vessels (mostly power barges) with a tonnage of 112,049 gross, as well as 162 oil-carrying tow-barges of 246,000 tons.

Apart from the large number of power barges and tow barges in oil transport on Russian waters, the Soviet has now two main fleets of tankers—all vessels are believed to be motorships. The Caspian fleet numbers 14, aggregating 66,254 deadweight tons, while the export fleet includes 24 tankers of 172,900 tons deadweight.

Tanker construction by Soviet shipbuilders has been exceedingly slow, and evidently capacity of the yards is extremely limited. Sormovo shipyard, seems able to lay down only two-large-sized ships yearly; a similar situation exists at Nikolayev.

It's a long hole that has no turning

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GULF EXPORT PRICES FOR MAJOR OIL PRODUCTS

Products		Mar. 8	Mar. 15	Mar. 22	Mar. 29
		Cents Per Gallon			
GASOLINE:	U. S. Motor	4⅞	4⅞	4¾	4⅞
	64/66-375 E.P.	5	5	4⅞	5
	59 Octane and below	5	5	5	5
	65 Octane and above	5¼	5½	5¼	5¼
AVIATION GASOLINE:	Gulf Export in cargo lots	9	9	9	9
KEROSENE:	44 w.w.	4⅞	4¾	4⅝	4⅝
	41/43 w.w.	4¾	4⅝	4½	4½
	41/43 p.w.	4¾*	4⅝	4½	4½
GAS OIL:	26-30 translucent	3⅞	3⅞	3¾	3⅝
	30 plus translucent	3⅞	3⅞	3¾	3⅝
		Dollars Per Barrel			
FUEL OIL:	Bunker C	95	85	85	85
	Cargo lots	80	75	80	75
	Diesel oil	1.90	1.90	1.75	1.75
		Cents Per Gallon			
LUBRICATING OIL:	Bright Stock No. 8	23	23	23	23
	Bright Stock No. 6½	22½	22½	22½	22½
	600 Warren E	20½	20½	20½	20½
	600 Unfiltered s.r.	16	16	16	16
(New York Export Market)	650 Unfiltered s.r.	18	18	18	18
	600 Flash s.r.	18½	18½	18½	18½
	630 Flash s.r.	21½	21½	21½	21½
	Neutral 200 No. 3	24½	24½	24½	24½
	Neutral 150 No. 3½	22½	22½	22½	22½
(South Texas Export Market)	Red oil 500 No. 5-6	8½	8½	8½	8½
	750	9	9	9	9
	1200	9½	9½	9½	9½
	Pale oil 500	8½	8½	8½	8½
	750	9	9	9	9
	1200	9½	9½	9½	9½
		Dollars Per Barrel			
CRUDE OIL:	East Texas delivered at Gulf for export	1.45	1.45	1.45	1.45

FREIGHT RATES

	Feb. 15		Feb. 23		March 2		March 8		March 16	
	Clean	Dirty	Clean	Dirty	Clean	Dirty	Clean	Dirty	Clean	Dirty
Gulf-U.K./Continent	27/-	26/-	25/-	24/6	23/-	21/-	21/-	20/-	20/6	19/6
Gulf-No. Atlantic	28c	28c	25c	25c	23c	24c	21c	18c	19c	17c

CENTRALAMER IN MEXICO

LONDON

ACTION of the Mexican government in confiscating the property of foreign owned oil companies operating in that country has directed renewed attention to the position of Centralamer Ltd., the British company organized some months ago with a capital of £10,000 to deal in Mexican oil.

It was announced only a few weeks since that the company had purchased 5,000,000 bbl. of oil from the Mexican government at a price of about one dollar per barrel. The oil was to come mainly from the Poza Rica field and was to be taken at the rate of four tanker loads per month, the company to furnish the transportation. It was announced further that the company planned to construct eight tankers at a cost of roundly $4,000,000, to advance $6,000,000 to the government for drilling and $7,000,000 for refinery construction. It was stated that the deal had been completed in principle, only the details to be settled.

The prime movers in the organization of Centralamer Ltd., so far as its published records show, have been members of Lambert & Bendall Ltd. who are fairly well known as coal merchants, shippers, and handlers of oil. In trade circles it is not considered that the house is large enough to finance a deal involving an investment of $17,000,000 or more and there has been considerable speculation as to whether other and larger interests were concerned. Since the announced purpose of Centralamer was to deal in oil belonging to the Mexican government or produced from government lands it is not directly affected by the action of the government against the private British and American owned companies.

Indirectly, however, Mexico's act of confiscation may have an effect on the fortunes of Centralamer Ltd. In view of the unfortunate experiences of other investors it is practically certain that no British bank or financial house would provide funds for any enterprise located in Mexico and it is very questionable whether it would be possible to market any considerable quantity of Mexican oil in Great Britain.

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THE SUPREMACY of sulphuric acid today as a purifying reagent in refineries is due largely to improvements in acid production and recovery processes developed by Engineers of this organization, and to their constant efforts to reduce treating costs by eliminating waste.

As stronger acid became necessary, this organization perfected not only more economical contact processes for obtaining acid of greater strength and purity, but also processes for direct regeneration of strong acid from acid sludges which could not be profitably handled in the conventional recovery systems.

Acid treating adds appreciably to the cost of every barrel of finished product, and the possible saving in this item by the use of modern CHEMICO processes and equipment should be made to swell operating income.

Throughout its corporate existence, CHEMICO has concentrated its major activities on sulphuric acid problems, including the development of improved processes and superior equipment, and the complete design, erection and modernization of refinery acid production and recovery plants. Its latest achievement, the CHEMICO Sludge Conversion Process, transforms acid sludge into clean, strong, regenerated acid and fully useful petroleum coke, with absolutely no remaining waste product — nothing left for disposal and no possibility of pollution controversies.

CHEMICO contracts on a lump sum basis for preliminary experimentation, plant and equipment design, erection of structures, installation of apparatus and delivery at full-capacity operation with operating crew trained. Performance is guaranteed, and acceptance asked only after impartial test has proven every agreement well met.

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have been installed
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Standard Oil Co. of Louisiana
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*Humble Oil & Refining Company
Solar Refining Company
Union Oil Company
Cosden & Company
California Petroleum Company
*Shell Company of California
*Sinclair Refining Company
General Petroleum Company
Pasotex Petroleum Company
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If you are handicapped by too expensive an acid recovery system, or by the waste and risk of unsatisfactory acid-sludge disposal, CHEMICO can tell you exactly what should be done, why, how and at what return on the investment. A preliminary discussion with our consultants involves no obligation.

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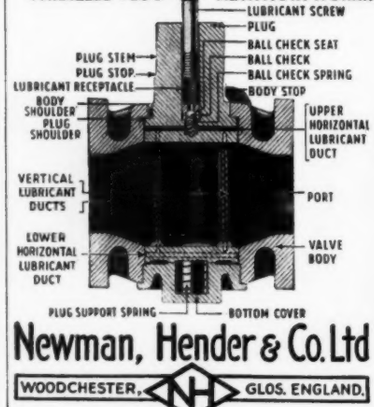

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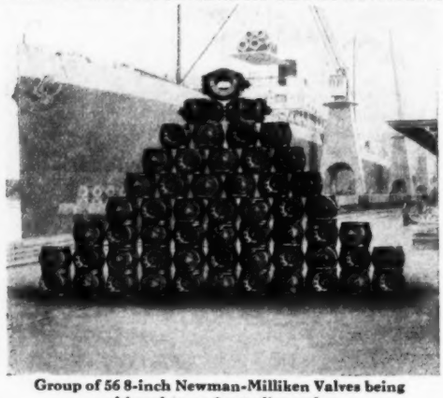

Group of 56 8-inch Newman-Milliken Valves being shipped to an Australian order

(Continued from page 43)

Driving to Surabaya, at the other end of the island, the party flew to Bali, that wonderland so recently put on the map by writers and artists who have discovered its unspoiled civilization, and seem to be doing everything possible to spoil it.

"Bali is everything you expect it to be after reading about it," says Frosty. "If you go through that part of the world, don't miss it."

And so back to Surabaya by plane, then by train to Batavia, and by steamer to Singapore, Hong Kong, Kobe, train to Tokio, steamer to Honolulu and San Francisco, reaching Long Beach in February.

All told, the trip took seven months, and 6,800 miles of it, more than a quarter the distance around the equator, was by plane and the equator was crossed six times.

"And if I'd visited all the fields that I planned to see," says Frosty, "I'd be going yet. It would have taken a couple of years. It would take six months just to see all the Dutch East Indies fields."

One thing struck him as peculiar—the disappearance of the American oil man in these foreign fields.

Traditionally, the American oil man, whether an engineer or a roughneck, has been a rover, and in earlier years was found in the most remote fields, exploring, drilling, producing, selling.

"That may still be true in Latin America," says Frosty, "but in the fields that I visited, and those I didn't reach, oil has gone to college. With the rising tides of nationalism in every country, the American engineer and driller alike have been replaced by the nationals of the countries where oil is found, or those who govern them as colonies.

"The Dutch, particularly, have trained young men for every department of their oil business, and a cleaner and more efficient lot of fellows you couldn't find.

"You've got to hand it to the Dutch! They have no oil in their own country, but they have developed it in their colonies, and merchandized it against the stiffest competition.

"Now, think! In these days of political 'isms,' set up in countries that have never known democracy, or where the people haven't been able to make democracy work, you find the Dutch, a democratic people in character, though their government happens to be a kingdom, building up their oil business under democratic conditions. They are not hampered by a blocked currency. What they need in the way of equipment, they order, and pay for.

"I guess if there is any one lesson to be learned from this busman's holiday of mine it is—you've got to hand it to the Dutch!"

LOOK at LIFE
in the oil well equipment industry–*thru the eye of Axelson's candid camera*

12

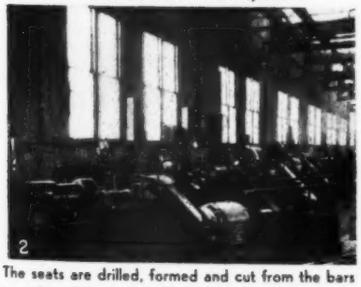
Axelson Deep Well Plunger Pumps are operating efficiently and economically in oil wells the world over. One of the important factors of plunger pump operation is the ball valves. This series of candid camera shots shows steps in the production of Axelson seats and balls, the care and precision with which they are made.

Alert oil men will recognize the outstanding features of Axelson production methods which make Axelson seats and balls as nearly perfect operating a ball valve as is possible to build in the world today.

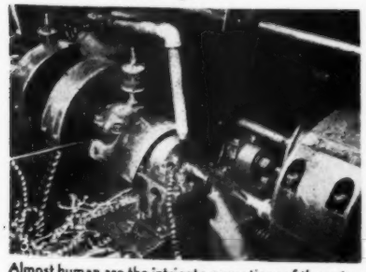
The final inspection of Axelson seats and balls is made by Andrew Andris, who has been making and testing balls and seats in the Axelson plant for more than 18 years. The skill and experience of Axelson employees are important factors in the production of pumping equipment. Axelson's reputation in the oil industry today is built on unceasing efforts to build a better product.

1

From large stocks of special alloyed, heat-treated steels Axelson seats are built to rigid specification. Samples from each bar are tested and inspected in the laboratory before they are accepted. Any deviation from Axelson standard means rejection.


2

The seats are drilled, formed and cut from the bars on automatic screw machines. Each of the four types of Axelson seats starts its manufacturing operations in this way. The uniform high quality of Axelson products is the result of constant vigilance.



Almost human are the intricate operations of the automatic screw machines. Unlike human beings, these machines do not vary, once they have been set. Every seat is uniformly cut. Each one looks like the next, but all must pass individual tests.

4

Additional finishing is done in the turret lathes. Each operation is followed by an inspection to insure precision and uniformity. Improper machining results in rejection at any point during the process of manufacture. Care at every step assures few rejections.

5

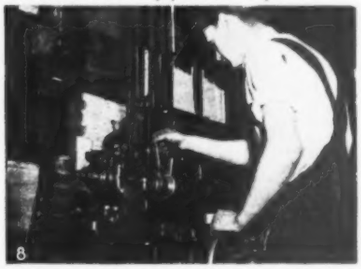
Imprinting name, size, material and code number. AXLOY and X-L seats are of corrosion-resisting steel. DURAX and ACME seats are of specially selected steel properly heat-treated for long life. Axelson builds ball valves to meet every well condition.

6

Automatic control of the heat-treating furnaces makes possible production of seats of uniform hardness. Each seat is tested before and after heating to make sure it meets specification. Here Axelson seats get hardened for a long life in a deep well plunger pump.

7

A powerful electro-magnet holds the seats in alignment as the faces are ground. Long-lived operation of Axelson seats and balls is due largely to the extreme care with which all machine operations are performed. Axelson has built oil equipment for 45 years.


8

Grinding the outside diameter of the seat and the face of the flange is a precision operation. On this depends the accurate centering of the seat in the valve, a matter of vital importance in the efficient operation of the pump. Axelson accuracy is a by-word in the industry.

9

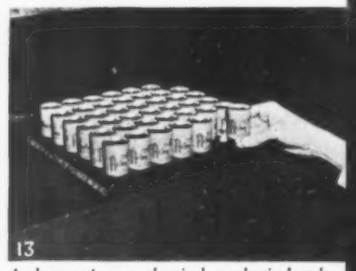
Axelson valve seats have a patented seating contour which is accurately ground on special Axelson grinding machines by skilled workmen. This patented Axelson seating contour means better valve operation for a longer time under any well conditions.

10

Perfect contact between each seat and ball is accomplished by lapping in patented machines designed and built by Axelson for this operation. It is here that Axelson balls and seats become partners for greater pumping production.

11

The seal between both sides of each seat and its ball must be perfect. Here we see seats and balls being tested. The ball and seat must hold a high degree of vacuum over a period of time and must not leak.


13

Axelson seats pass chemical, mechanical and metallurgical tests. These tests assure the operator of a ball valve which will give maximum service in the well. Axelson AXLOY balls and seats are ready for a long and productive life.

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WORLD OIL PRODUCTION—Official Figures

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified—Table revised monthly

(Figures in U.S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries)

	March 1937	April 1937	May 1937	June 1937	July 1937	August 1937	September 1937	October 1937	November 1937	December 1937	January 1938	Preliminary Figures February 1938
United States	106,724,000	104,979,000	110,911,000	105,812,000	110,721,000	115,090,000	109,980,000	110,911,000	104,206,000	106,579,000	106,007,000	93,500,000
Russia[2]	15,907,051	15,401,771	18,130,230	17,953,812	18,580,752	17,183,259	16,663,000[1]	17,600,000[1]	16,923,000[1]	17,600,000[1]	17,647,000[1]	13,591,000
Venezuela	15,066,287	14,686,657	14,498,968	16,260,492	16,469,071	17,861,784	17,640,872	17,979,227	17,044,016	17,096,298	15,271,901	13,792,479
Iran[3]	6,437,516	6,329,968	16,353,014	6,752,478	7,213,398	7,313,264	7,198,034	7,075,122	6,821,616	6,637,248	6,687,000[1]	6,048,000
Netherland India	4,415,436	4,348,185	4,553,298	4,464,725	4,708,460	4,672,953	4,586,638	4,766,689	4,626,395	4,671,582	4,245,587	4,235,000
Roumania	4,595,000	4,412,000	4,494,000	4,151,000	4,317,000	4,293,000	4,256,000	4,313,000	4,162,000	4,198,000	4,099,000	3,751,692
Mexico	4,307,952	4,249,838	3,387,950	3,338,311	3,848,587	2,800,868	3,432,101	4,372,808	4,211,293	4,349,415	4,141,977	4,017,000
Iraq	2,709,260	2,665,259	2,747,102	2,344,213	2,429,587	2,429,787	2,513,145	2,663,244	2,645,099	2,431,532	2,670,844	2,385,464
Colombia	1,622,226	1,660,469	1,678,580	1,724,173	1,681,799	1,592,592	1,617,433	1,811,759	1,797,625	1,824,956	1,784,638	1,557,000
Peru[4]	1,484,491	1,432,874	1,456,329	1,432,398	1,488,965	1,494,467	1,453,712	1,492,971	1,432,508	1,481,701	1,365,152	1,340,000
Argentina	1,394,757	1,361,540	1,381,485	1,339,940	1,355,420	1,345,513	1,369,767	1,360,000[1]	1,365,000[1]	1,370,000[1]	1,378,000[1]	1,289,000
Trinidad	1,287,097	1,301,260	1,351,198	928,752	1,377,547	1,433,474	1,358,600	1,393,317	1,300,485	1,349,908	1,378,021	1,304,819
Burma[5]	635,792	625,937	690,501	638,874	633,401	679,335	701,066	660,000[1]	653,000[1]	690,000[1]	662,000[1]	598,000
Bahrein[6]	799,994	659,557	432,748	684,348	585,917	254,937	662,861	847,988	749,354	805,236	805,800	707,379
Brunei[7]	389,612	363,226	376,191	349,500	353,313	373,760	341,111	351,711	376,487	405,623	409,592	381,052
Poland	316,844	318,360	318,360	310,780	318,360	318,360	310,780	325,940	318,360	325,940	319,876	295,620
Germany	243,012	247,060	245,088	249,434	267,847	279,727	282,155	288,926	272,665	277,551	268,028	257,967
Canada[8]	175,575	188,014	192,845	209,181	241,737	288,934	298,753	342,452	341,517	408,580	457,408	413,158
Japan[9]	207,423	198,898	206,544	200,092	204,710	214,819	205,914	210,228	214,330	211,436	218,594	214,000
Ecuador	180,727	181,352	189,658	182,696	186,175	184,780	178,122	182,053	176,252	178,776	187,525	171,138
British India[10]	167,418	162,699	172,458	181,436	168,467	168,034	159,226	200,000[1]	180,000[1]	170,000[1]	175,000	157,000
Sarawak[11]	136,887	130,481	134,523	131,625	143,445	138,031	134,311	133,684	126,439	131,901	137,497	126,578
Egypt[12]	93,432	89,480	97,077	98,021	99,182	97,818	100,699	97,203	95,082	94,509	91,927	84,974
France	43,053	41,865	42,096	45,445	42,125	43,367	44,000[1]	42,339	42,639	42,368	43,000[1]	38,000
Austria	7,280	8,690	27,510	18,410	18,890	13,860	17,010	18,620	20,850	19,320	25,620	27,000
Czechoslovakia	9,383	9,574	8,824	10,824	11,529	10,125	9,667	10,865	12,297	11,734	11,070	13,715
Others[1]	29,200	28,300	29,200	28,300	29,200	29,200	28,300	29,200	28,300	29,200	29,200	26,400
Totals	169,386,705	166,082,314	174,106,777	169,841,260	177,495,884	180,606,048	175,543,277	179,480,346	172,142,609	173,291,814	170,518,257	150,323,435

[1] Estimate. [2] Russian Sakhalin included with Russia.
[3] Anglo-Iranian Oil Company Ltd figures revised—fuel oil returned to ground has been deducted.
[4] International Petroleum Company and Lobitos Oilfields Ltd. figures combined.
[5] Does not include Assam and Punjab, which are listed separately under British India.
[6] Bahrein Petroleum Company Ltd. figures.
[7] British Malayan Petroleum Company Ltd. figures.
[8] Includes natural gasoline production.
[9] Japanese Sakhalin, Taiwan (Formosa) and Hokkaido included with Japan.
[10] Excluding Burma.
[11] Sarawak Oilfields Ltd. figures.
[12] Anglo-Egyptian Oilfields Ltd. figures.

Official Crude Oil Production Figures for 1932 to 1937

	Daily Average to Feb. 28 1938 (Bbl.)	Daily Average 1937 (Bbl.)	Total to Feb. 28 1938 (Bbl.)	Total 1937 (Bbl.)	Total 1936 (Bbl.)	Total 1935 (Bbl.)	Total 1934 (Bbl.)	Total 1933 (Bbl.)	Total 1932 (Bbl.)
United States	3,381,474	3,500,418	199,507,000	1,277,653,000	1,098,516,000	996,596,000	908,065,000	905,656,000	785,159,000
Russia	529,458	553,305	31,238,000	201,856,661	199,635,921	184,008,033	175,635,783	155,596,429	155,927,997
Venezuela	492,616	513,133	29,064,380	187,293,734	155,270,840	148,809,057	136,098,681	117,113,940	115,615,782
Iran*	215,847	215,732	12,735,000	78,741,813	62,977,950	57,520,488	57,902,092	54,440,075	49,516,697
Netherland India	143,739	148,255	8,480,587	54,112,933	47,961,744	45,307,913	45,107,828	41,234,498	37,988,913
Roumania	133,063	142,948	7,850,692	52,176,000	63,532,846	61,270,072	61,849,306	53,919,708	53,651,978
Mexico	138,288	127,275	8,158,977	46,455,687	41,027,915	40,240,563	38,171,946	34,000,830	32,805,496
Iraq	95,700	83,846	5,056,308	30,603,660	29,913,150	27,410,983	7,639,849	1,094,915	871,840
Colombia	56,638	55,609	3,341,638	20,297,543	18,756,110	17,597,655	17,337,900	13,156,126	16,415,214
Peru*	45,850	47,833	2,705,152	17,459,112	17,593,149	17,056,555	16,314,381	13,257,318	9,899,265
Argentina	45,203	44,482	2,667,000	16,235,910	15,457,960	14,297,025	14,021,901	13,690,556	13,138,747
Trinidad	45,472	42,472	2,682,840	15,502,502	13,237,030	11,671,224	10,894,363	9,561,353	10,126,121
Burma	21,351	21,351	1,260,000	7,792,972	7,587,718	7,181,113	7,278,859	7,114,311	7,073,437
Bahrein	25,647	21,266	1,513,179	7,762,264	4,644,635	1,264,807	285,072	31,377	902
Brunei*	13,401	12,047	790,644	4,397,038	3,355,086	3,359,054	2,741,341	2,070,162	1,220,426
Poland	10,432	10,404	615,496	3,797,580	3,869,575	3,901,881	4,011,336	4,174,079	4,219,634
Germany	8,915	8,625	525,995	3,148,300	3,076,858	2,967,438	2,204,402	1,656,602	1,594,807
Canada	14,755	7,992	870,566	2,982,572	1,504,287	1,447,204	1,410,895	1,145,333	1,044,412
Japan	7,334	6,817	432,594	2,487,841	2,403,072	2,294,878	1,872,837	1,504,412	1,683,439
Ecuador*	6,079	5,922	358,663	2,161,436	1,942,467	1,731,785	1,636,619	1,619,902	1,597,641
British India	5,637	5,640	332,000	2,059,464	1,978,329	2,037,810	1,921,863	1,628,803	1,743,878
Sarawak*	4,476	4,535	264,075	1,655,565	1,574,196	1,806,795	1,975,617	2,244,331	2,369,338
Egypt*	2,998	3,187	176,901	1,163,267	1,262,666	1,255,151	1,527,252	1,653,535	1,071,976
France	1,373	1,387	81,000	507,067	534,063	529,664	700,000	786,366	755,146
Austria*	892	631	52,620	231,070	52,311	46,312	29,204	6,020	840
Czechoslovakia*	420	339	24,785	123,474	126,603	136,580	177,797	121,695	126,603
Other countries	942	942	55,600	344,000	303,300	352,500	401,000	385,500	369,800
Total	5,448,000	5,586,393	320,841,692	2,039,002,465	1,798,095,781	1,652,098,540	1,517,213,124	1,438,865,179	1,305,587,329

*Revised by official sources.